THE

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ELECTRIC TRACTION ON RAILWAYS.

THE recent appearance of the report of the Royal Commission on London Traffic, and that of the Advisory Board of Engineers appointed by that Commission, to which we have referred in previous issues, has led us to consider whether, in view of the conclusions arrived at by the Commission, and the recommendations made by the Advisory Board of Engineers, there is any reason to alter the opinions we have so often expressed in these columns as regards the necessity of electric traction being adopted on our suburban lines. We have already discussed and criticised the reports, and although the former is almost exclusively a tramway report, yet we consider that it fully confirms that necessity for action on the part of our railways which we have always preached.

The object of the Royal Commission was not primarily to investigate what railways should do, but to see what additional means of rapid transit were required to meet the constantly growing requirements of Greater London.

Judging by remarks made at the last half-yearly meetings, railway companies are seriously alarmed at the severe competition in local traffic which they have met at the hands of electric tramways, and they have not yet apparently realised that very probably the electric tramways, instead of damaging them, may actually confer a benefit upon them, provided, of course, the railway companies are prepared to live up to the requirements of the public as regards frequency and rapidity of service. What the tramways are doing at present is to take away the short-distance traveller from the railways; but unless railways considerably improve their local services, they will find that the tramways may also compete for long-distance traffic.

Experience has shown over and over again that once the public have learnt to appreciate and utilise means of rapid transit, the growth of these means can hardly keep up with the demand, and considering how backward London is in this respect as compared to other cities, there is evidently a great deal to be done to improve the means of locomotion amongst which, as we have always held, existing railways should play a very large part.

Thus, in Greater London to-day, according to the Royal Commission, the average number of journeys per head of population amounts to only 170 per annum, as compared with 200 in Paris, 270 in Berlin, and 300 in New York, and a careful investigation of the traffic statistics of Berlin and New York fairly demonstrates that the constantly increasing facilities of travel are causing greatly increased passenger traffic, the limit of which has certainly not yet been reached.

The report of the Advisory Board of Engineers contains some interesting figures, which should be taken to heart by the railway companies, as showing the great importance to them of the London traffic problem. The Commission shows that out of the total number of passengers journeying in and out of London every day, which amounts to nearly $\frac{3}{4}$ of

a million each way in round numbers, 70 per cent. are carried by the railways, the remaining 30 per cent. being divided about equally between omnibuses and tramways. In this connection the remarks of Mr. Llewellyn Smith, in the introduction to the Board of Trade Railway Returns, are specially worthy of attention. In this introduction Mr. Smith states that since 1900 the number of tramway passengers carried in the United Kingdom has become greater than the number of third class passengers carried by railways, and since that year the increase has been proportionally much greater in the case of tramway passengers than in the case of railway passengers. The following figures extracted from the Board of Trade Returns are not without interest :—

Year.	Increase in third-class railway passengers.	Increase in tramway passengers.
1899-1900 ...	3·5 %	15·2 %
1900-1901 ...	2·9 %	12·5 %
1901-1902 ...	1·1 %	16·4 %
1902-1903 ...	0·5 %	20·6 %

But beyond this question, there is a further one for railways to consider, namely, the increase in total working expenses per train-mile, which has grown, according to the Board o Trade returns, from 33·26d. per train-mile in 1895, to 41·27d. per train-mile in 1904, as far as England and Wales are concerned.

It is held by some that railway companies should not be anxious to increase their local traffic, and in fact, on the contrary, should be only too glad to get rid of this entirely ; in some quarters it has even been asserted that railway companies might be pleased to part with their entire passenger traffic if they were allowed to retain their goods traffic. Such ideas are all very well, but their realisation is, for the present, at least, beyond the bounds of practicability, and considering the efforts which, amongst others, the Great Eastern Railway Co. has made to encourage local traffic, it is hardly possible to doubt that, if it came to the point, the railways would be very loath to part entirely with their suburban traffic. This traffic is by no means small, as may be gathered from the figures given by the Advisory Board of Engineers to the Royal Commission, where it is stated that at Liverpool Street Station alone, the Great Eastern Railway Co. deals approximately with 65 million passengers per annum.

Another argument against offering increased facilities for handling suburban traffic is that long-distance traffic is constantly increasing, and that even with the present insufficient local train service, the terminal accommodation is such as to make it impracticable to run an increased number of trains. Hence, it is said, railway companies feel rather inclined to put obstacles in the way of the suburban passenger. The above reason is, as a matter of fact, one of the chief arguments which is to be cited in favour of electric traction. We have so often referred to the numerous advantages of electric traction for suburban lines, that it would be a work of supererogation to repeat them here again at length. We should like, however, specially to attempt to drive home the fact that it is not so much any economy in operating expenses which should weigh with railway companies in considering electric traction, as the greatly increased facilities of handling traffic introduced by this new means of locomotion, which practically results in more than doubling both the carrying capacity of the line and the station capacity at the termini, besides enabling the service to be worked economically and in such a manner as to be most suitable to the requirements of local traffic. The following quotation from the Royal Commission's Report exactly expresses our own views, and we should recommend it to the very serious consideration of our large railway companies :—

"We look for the relief of overcrowding to the future adoption of electric traction for suburban trains, and to the increase in the number of trains run which would probably follow this change in motive power. Trains of uniform but not excessive size, run at very short intervals, afford the best way of meeting the evil of overcrowding.

"So long as trains are hauled by steam engines, we do not think that much improvement in the speed of suburban train services can be looked for. When electric traction is adopted, the advantage of quicker acceleration will be secured, and the readier adaptability of electric trains to all varieties of traffic requirements will, we hope, enable suburban train services to be greatly improved, and the journey times of trains to be reduced substantially.

"It is, we think, evident that the introduction of electric traction will lead to a great improvement of suburban and urban railway facilities in London ; the speed of all trains worked by electricity, especially those which stop at many stations, will show substantial increase over the speed of steam trains. It will, we believe, also be found, that electric traction, apart from its other advantages, will enable the railway companies to increase the number of trains working in and out of the terminal stations, and thereby add largely to the facilities afforded for suburban traffic."

"*We hope, therefore, that there may be no great delay before the railway companies serving London adopt electric traction for the working of their suburban train service.*"

Purchase—by Faith.

The keynote of the lengthy discussion by the members of the Electrical Contractors' Association on the rubber and other materials used in insulating cables and wires (o which we give an account in another part of this issue), was the fact that their purchases of rubber-covered cables were not based on a knowledge of the actual properties of the material supplied, but on the assurances of the seller. In a case of this kind the axiom that knowledge is confined to things visible does not apply. The present appearance of a cable in which inferior substitutes are employed is one thing, but the appearance after some months of exposure to deleterious influences, both external and internal, may be another story. Therefore, as more than one speaker observed, purchases are made on faith in manufacturers' assurances and guarantees. Faith becomes, in this, as in other instances, "the substance of things hoped for."

In the present stress of commercial competition, between electric lighting and rival illuminants on the one hand, and between rival contractors on the other, the obvious temptation to have recourse to cheap cables has serious effects. The jerry wiring contractor employs it, his installations barely outliving the fungoid—we cannot say butterfly—life of his firm. Its fruits are a spreading of a distrust of electric lighting, for one consumer who has to have his premises rewired, perhaps, half-a-dozen of his friends are temporarily or permanently deterred from having theirs wired at all. High standards of workmanship and high grades of material can alone prove a firm foundation for a successful business by any firm of wiring contractors. Aware of the high price of rubber, and knowing that the detection of substitutes is a matter for experts (expert evidence in the event of litigation being, moreover, a grade of knowledge peculiar to itself) it is scarcely to be wondered at, that contractors are likely to put forward the question as to whether high price invariably means high-class materials. Rough commercial tests are unattainable. At present high conductivity wire is always specified, but it is dubious whether the simple test which would tell the contractor whether this was supplied is ever made. The conductivity is taken on faith, and justly so, on account of the fact that only electrolytic copper is now used. With rubber, where adulteration is rife, not only

during making up at the works, but even at the plantation, faith is not a very comforting basis for purchase. It remains for the manufacturer to set a very high standard with regard to the raw material used, in order that faith in his firm may be justified, and to educate the contractor (as was done by Mr. Beaver in the paper to which we refer) in order that he may take all reasonable precautions to give good material fairplay. If such fairplay be not accorded, it is as cheap to consign ultimately to the scrap heap a low grade product as a badly-used high grade product. So long as purchase has to be by faith, the demand is mutual. The manufacturer must supply the best material, and the contractor must take precautions against unfair uses of the material he buys.

The City Gas Lamps.

No attempt is being made by our friends the gas people to disguise their delight at what they regard as their victory in the City. The *Gas World* of last week fairly rubs its editorial hands over it.

It takes as its text an article in the Engineering Supplement of the *Times*, in which it is pointed out that the arc lamps in the City were of "an extremely antiquated type" and that the comparison between them and modern high pressure gas lamps is most unfair.

"The obvious rejoinder to this plea" says the *Gas World* "is that the party in possession, the electric lighting company, should have seen it betimes. If they could not, or would not, keep their lamps up to date, the fault or loss has been their own; and in losing custom they but share the fate common to shopkeepers who allow their stock to get old fashioned." We have already explained to our readers that the electric supply company in question was never given the opportunity of tendering against the gas company, or of installing up-to-date lamps. In a manner which, from the public standpoint, is not easily explained, the gas company was asked to give a quotation for its best system without any corresponding invitation being issued to the electric supply company. The result was that the lowest, *and only*, tender was accepted, and the arc lamps were replaced by gas.

What a triumph, indeed, for the gas interests! What a victory for gas over electricity!

The *Gas World*, in the same paragraph, makes the following statement: "In no respect were their lamps (the City arcs) inferior to any others in use elsewhere." We most emphatically protest against this assertion. To put it bluntly, it is not a fact. These arc lamps were installed in 1891, since when many improvements have been carried out in the manufacture of such lamps, and it is absurd on the face of it to say that the arc lamp of to-day is no better than the lamp of 14 years ago. There is as much resemblance between the old City of London arcs and modern flame lamps as between a batswing gas burner and a new incandescent mantle. The difference between the lighting of Fleet Street by these old arc lamps and a street illuminated by modern ones, is enhanced by the fact that the lights in the former thoroughfare are obscured by inverted muranese lanterns.

All this is obvious to an impartial observer, and such misstatements as are made by our contemporary cannot be commended as a straightforward way of attempting to forward the interests of gas.

Institution of Electrical Engineers.

On Thursday next the meetings of the Institution in London will recommence. Presumably they will be carried on in the time-honoured primeval fashion—papers will be read, *verbatim et literatim*, by readers whose forte, as a rule, is anything but reading, and in the few minutes remaining after this painful process, remarks less or more apropos to the subject will be dropped by members and others who regret that they "have not had time to read the paper, but would like to say a few words," of which the first moiety are devoted to eulogy of the author and effusive thanks for the paper, and the second half to abuse of the opinions at which he is supposed to have arrived. Members of Council will speak at length out of the fullness of their hearts; members less accustomed to oratory, who really have read the paper and made notes thereon, will be pulled up for "reading" their remarks, and invited to bury them in the *Journal*. The men who do the work, and know, will be awed into silence by the weight of learning visible on the front bench.

Meanwhile, the local sections will repeat their annual performance of pouring forth practical solid information of the kind that is wanted, and valuable papers will be taken to the provincial centres in order to ensure adequate discussion.

Need we say that we sincerely trust that our gloomy forecast may prove to be hopelessly in error? It is based upon ample precedent; but it is never too late to mend. What we want is the American procedure: papers sent to members in advance, and *not read at the meeting*; a discussion starting at 8.10 p.m., with the minimum of flattery—surely the vote of thanks should suffice; a *live* discussion—immediate replies to questions, not set speeches followed by a general reply, as likely as not relegated to the *Journal* for lack of time.

There is too much of the formal procedure; what is wanted is an interesting and useful shop talk. It has been suggested to us that there should be meetings of a London Local Section, in addition to the general meetings, and we are inclined to believe that the idea is worth consideration. It is also a debatable question whether the students, who constitute probably one-half of the audience at the crowded general meetings, should be admitted to these.

However, we cannot discuss these points at present; we will conclude with the sincere hope that, under the energetic control of the new President, the meetings of the I.E.E. will be raised to a higher plane.

L.C.C. as the Electric Octopus.

Our readers are only too familiar with the protracted proceedings which took place last year before the Parliamentary Committees, when the L.C.C., almost single-handed, tried to hold the fort against the Administrative County &c., and other companies—but mainly against the former. The opposition was at great pains to show that the existing undertakings could and would supply electrical energy as cheaply as the Administrative Co., and that the latter was a superfluous and objectionable innovator.

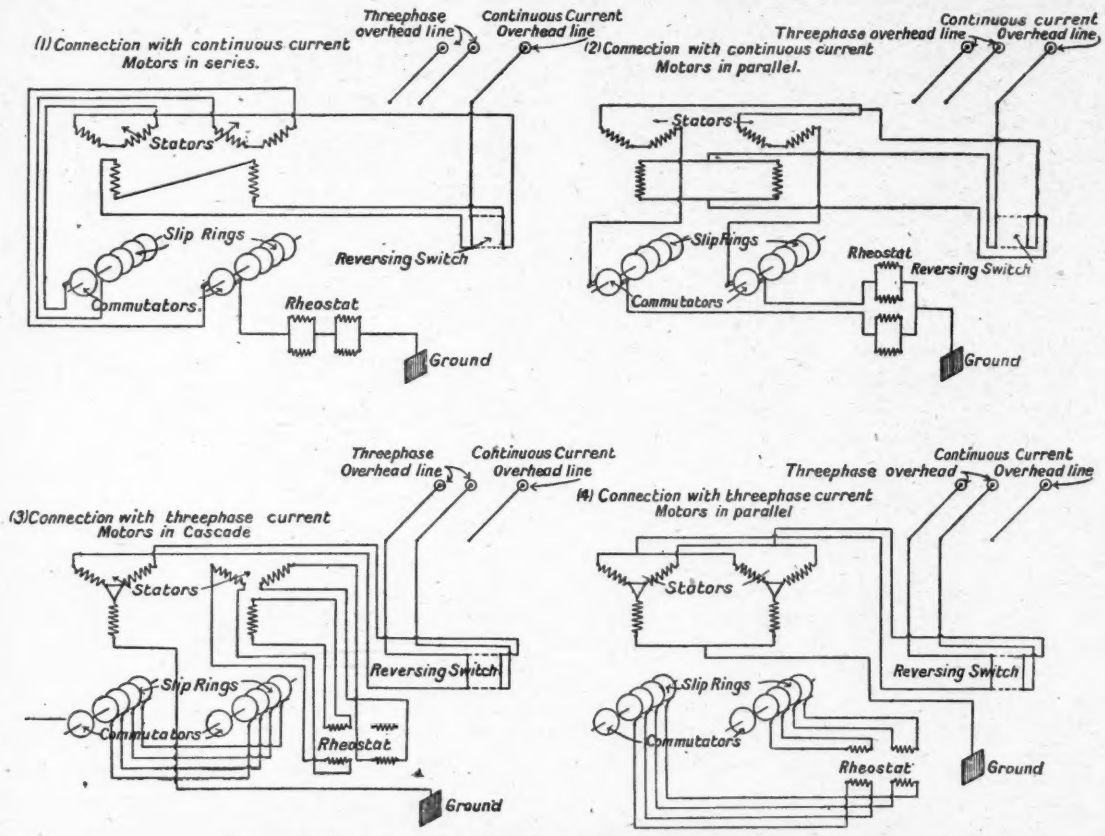
The curious and amusing spectacle was witnessed of the existing London supply companies fighting side by side with some of the municipal suppliers against the Administrative Co. and the vast majority of the borough councils, including some of the latter that own supply undertakings.

Now we learn that the L.C.C. is preparing to bring forward a Bill to constitute it a bulk supply authority; some of the Borough Councils are also combining to promote a Bill of their very own, for the same purpose; and of course the Administrative Co.'s Bill will come forward again. We may look forward, therefore, to a delightful "three-cornered duel," in which the L.C.C. and the Company will fight the Borough Councils; the Company and the Borough Councils will fight the L.C.C.; and the Borough Councils with the L.C.C. will fight the Company. Could anything be more ludicrous—or pitiable? Truly municipalisation in London has reached the extreme limit of absurdity and futility.

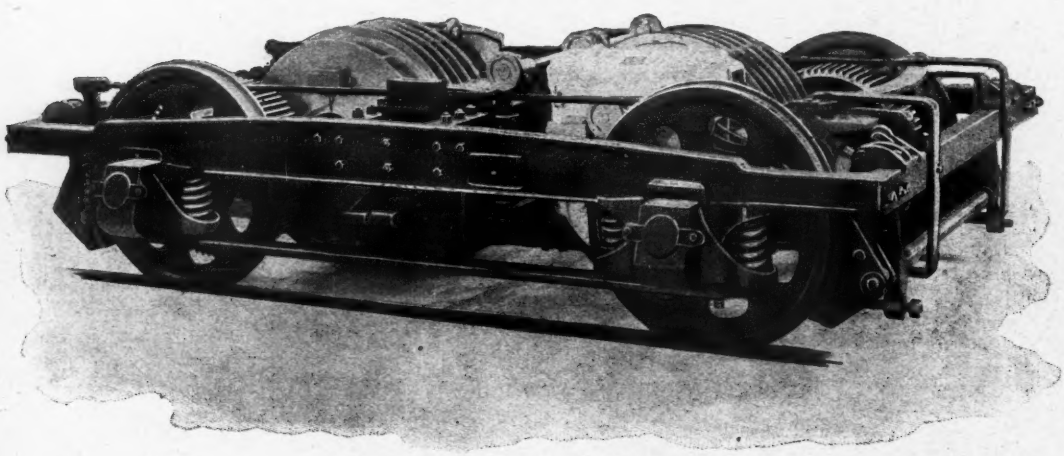
Those of our readers who remember the famous picture of "George Washington trying to tell a Lie" will smile as they regard the attitude of the L.C.C. and the Borough Councils concerned. Eating one's words is never a congenial occupation; but how can they persuade anyone that their attitude is not inconsistent? The Parliamentary Committees will put it down to one reason only—the true one—viz., animosity to private enterprise; and we prophesy a speedy triumph for the Company.

A UNIQUE TRACTION EQUIPMENT.

Great pressure on our space alone prevented us from describing the three-phase direct-current traction equipment which was shown by Messrs. Bruce Peebles at the Tramway Exhibition, and we take this opportunity of reproducing a photograph of the truck as it appeared on the stand, together with diagrams of connections.



Diagrams of Connections of Three-Phase Direct-Current Equipment.



Bruce Peebles A.C.—D.C. Motor Truck.

The motors are of 135 h.p. each, and are to run over a 30-mile interurban line belonging to the Canadian South-Western Traction Co., London, Ontario. The line is supplied with three-phase current at 1,100 volts, but the cars have to run over the 500-volt d.c. lines in the town of London.

The motors have a distributed winding, and an armature with commutator and slip rings, wound similarly to a series d.c. armature on the two-circuit principle.

When on d.c. the motors are controlled in the standard way; when on a.c. the brushes are lifted off the commutator from the platform, and the motors are started in cascade, and afterwards cut into parallel.

Particular interest attaches to this equipment, as it is improbable that it will be duplicated elsewhere, unless a three-phase line is in existence, and it is desired to run the cars on a d.c. line as well. The added complication of the three phases seems to offer insufficient, if any, advantages over the single-phase direct-current combination.

We believe that the interurban line over which these cars will run is likely to be extended to three or four times its present length almost immediately.

Ashton-under-Lyne Workhouse Lighting.— The L.G.B. has refused the application of the B.G. for a loan for the purpose of laying down an E.L. plant at the Workhouse, and has also intimated that, upon the information at present before it, the Board considers that the circumstances will not justify it in assenting to the wiring of the Workhouse for the electric light.

PROCEEDINGS OF INSTITUTIONS.

IS MACHINE STOKING ECONOMICAL?

By Alfred W. Bennis, M.I.Mech.E., A.I.E.E.

(Paper read before the Keighley Association of Engineers.)

Possibly the most complete answer to this question is that at the present time there are millions of boiler horse-power machine-fired. The most careful and elaborate tests made by the manufacturers of mechanical stokers, and the engineers representing the companies who use these stokers, have indisputably demonstrated that mechanical stoking — machine firing—is in every way more economical than manual stoking—hand firing.

To crowd on as much coal at a time as the furnace will hold—the bigger the lumps the better—to shut the door and then trust to luck has already been laid down by a M.I.E.E. as "the main object in life of the average human stoker," and all who have a practical acquaintance with the type will agree as to the accuracy of this description.

And here we would point out that the term "average firemen" implies that there is a fireman who may distinctly claim to be "beyond the average." Such a man recognises that the principle of good stoking is to fire lightly and often and to keep the fires as regular and even as possible, and it is his constant aim to regulate the draught to the duty required, keep a clear fire and an even steam line.

It is a recognised fact that in the actual manipulation of fires the efficiency of the individual fireman, even of the most expert, varies widely. This fact has been attested again and again by a most careful system of prolonged comparative tests made to determine the fuel economy of boilers and engines combined when running at constant load, the furnace and boiler design being similar, and the furnace fired by the skilled fireman of the manufacturer. Under the circumstances the variation in results was as much as 15 per cent.

Stoking.—In order to illustrate the personal element introduced in good and bad stoking, we may quote the competition which was carried out at Messrs. Davy Bros., of Sheffield; five stokers were made to fire the same boiler with the same coal and with the steam pressure about the same. The best stoker was able to obtain an evaporation of 9 lb. of water per lb. of coal, the worst evaporation being 7·4 lb. per lb. of coal. The difference is here 22 per cent. The opportunities afforded for increasing the efficiency of the boilers were, in this instance, limited; a well-laid fire, which by constant attention is prevented from burning into holes, is one of the chief items in securing a high evaporation. Keeping the fire-bars clean, and regulating the dampers for a maximum quantity of air just after firing, contribute greatly to high efficiency. Beyond these points there is little opportunity for exercising skill in stoking, and yet these tests show clearly how very important the simple operations involved in firing a boiler become. The very simplicity is the one cause for neglect.

It is the result of such tests, which brings out so clearly the possibility of this variation in hand-stoking, that provides one of the strongest arguments in favour of the production of the mechanical stoker which, when well designed, fulfils the condition of a good fireman and secures uniformity of product, the functions of the machine being varied as required by positive adjustments.

The testimony of many of the most experienced and practical experts is entirely in favour of machine firing, thus:—

Prof. Breckenridge, of the University of Illinois, says:—"All plants above 500 H.P. should have mechanically-operated furnaces on account of their freedom from smoke and great economy in fuel and attendance."

We go further, and say that all plants over 300 H.P. should be mechanically fired.

Mr. McCulloch, manager of the Chicago Street Railway, says:—"There is a decided necessity for stokers in all power plants," and he adds that "they are more efficient on low grade fuel, and by their use, together with coal and ash-handling machinery, the employment of a large number of labourers in the boiler house is dispensed with."

In a paper read before the Ohio Society of Mechanical, Electrical and Steam Engineers for the purpose of showing the relative cost of hand-firing in large plants, when compared with modern coal-handling equipment, combined with mechanical stokers, the following particulars were given. These were obtained from actual records in a large establishment, containing about 7,500 boiler H.P. The plant was operated for some time after construction without coal-handling machinery of any kind except small hand-cars, which were loaded by hand from railway cars outside the building, and then hauled up a slight incline to the boilers. The cost is given for the month of May, 1900, and for May, 1901. In the first instance *no* mechanical means were employed. In the second, mechanical stokers and conveying machinery were used. The only handling necessary was shovelling into the conveyor, and that might have been greatly cheapened by using a track hopper. Existing conditions made this impracticable. The cost of hand-firing compared with mechanical stoking is given as follows:—

May, 1900.—Sixteen firemen and one helper, wages £196 7s. 2d.; tons burned, 4,292; cost per ton 10·9799d.

Eleven coal and ash men, wages £126 18s. 8d.; cost per ton, 7·0978d.

May, 1901.—Three firemen and two helpers, wages £57 11d.; tons burned, 6,975; cost per ton, 1·9802d.

Eleven coal and ash men, £130 18s.; cost per ton, 4·504d.

The saving in wages per ton handled is thus shown to be 11·5935d., which, estimating 6,975 tons per month, is a saving of over £4,000 per year.

An item of great importance in deciding upon the methods of handling coal in steam-power plants is the cost of boiler-room labour. An estimate which is probably not far from accuracy is that which puts the cost of moving coal by hand or wheel-barrow at 6d. per ton for short distances. One man, besides one night man, can run an engine and fire about 10 tons of coal per week. One man, besides an engineer and night man, can fire about 35 tons per week. These figures do not admit of the night man refusing such work as banking, cleaning and starting, and are for average conditions. When the coal has to be wheeled for long distances a fair allowance should, of course, be made.

Where boiler houses are small, or by reason of their arrangement, an elevating and conveying plant cannot be conveniently put down, the use of small elevators is advocated, either one elevator to each boiler, or one to every two boilers. Take a case in point, a firm has two boilers fairly hard fired:—

Wages, one engineer	£2 5 0
„ one fireman	1 10 0
Total	£3 15 0

With an elevator to the stokers, a lad at 16s. per week can comfortably keep steam, and still have plenty of time for keeping the boiler house clean, under the supervision, of course, of the engineer. The wage bill would then be:—

One engineer	£2 5 0
One lad	0 16 0
	£3 1 0

The elevator would cost, say, £60; upkeep, say, 5 per cent. — £3; oil, &c., £2; so that the saving would work out:—

$$\frac{14s. \times 50 \text{ weeks}}{20} - (3 + 2) = £30 \text{ per annum, or 50 per cent. on}$$

the outlay.

Many firms are going in for this kind of plant, such as:—

The River Etherow Bleaching Co., Ltd., Hollingworth, near Manchester, who are putting in 10 sets.

Messrs. the Coventry Corporation.

Messrs. Archibald Walker & Co., the distillers, of Liverpool.

Messrs. Rowntree & Co., Ltd., York.

In connection with this, we may take the last firm—who are known all over the world—Messrs. Rowntree, the chocolate manufacturers, of York—who are making a saving of over £2,000 per annum on an outlay of less than £1,200 for stokers and elevators on the five Lancashire boilers. These figures may, of course, be verified.

Let us now take some of the objections advanced by more or less inexperienced persons to the use of machine firing, and among these may be mentioned the following:—

1. There is no economy.
2. The lower-grade coal is not worth burning, and, in any case, it smokes.
3. The cost of up-keep is excessive.
4. Where the load varies, machine firing has to be supplemented by hand-firing.
5. The machine is frequently out of order.
6. Machine stokers reduce the capacity of the boiler.

Taking these objections in order, we would say that:—

1. It is customary now with all manufacturers of first-class machinery of the kind to install it with a guarantee of saving. The economy effected varies between 25 per cent. and 200 per cent. on the outlay—*i.e.*, on the initial cost of the machinery.

2. With regard to this objection, we would assert on behalf of the manufacturers of this type of plant that very many practical tests have established the claim that the work done, whether with low or high grade coals, is practically the same.

The Glamorgan Coal Co., Ltd., one of the largest collieries in South Wales, recently made some elaborate trials of stokers and hand-firing. Hand-firing evaporated about 6,000 lb. of water per hour. The stoker on the same boiler gave with—

Colliery small	9,469 lb.
Unwashed peas	11,142 lb.
Washed peas	11,335 lb.
Washed nuts and beans	10,160 lb.
Unwashed beans	9,720 lb.
Unwashed nuts	10,390 lb.
Washed Colliery small	10,684 lb.
Dry Duff	8,301 lb.

So that the variation in evaporation obtained on the same boiler with these different fuels was never very great; though the price varies many shillings per ton between the best and worst of the lot, and, curiously enough, the coal which gave the best economical efficiency—the washed nuts and beans mixed—did not give the highest evaporation.

3. In answer to the third objection, it may be said that if stokers are reasonably looked after, the cost of upkeep does not amount to 10 per cent. on the saving made by the machines.

The Leeds electric lighting station have some 40 machines, and their average upkeep cost comes to less than £1 per boiler per annum.

The stokers at work at the lighting station in your own town of Keighley have only cost 7s. 9d. per annum per boiler for repairs; they have been at work five years. These figures were kindly given by Mr. Smythe.

E

4. This objection may be answered by an emphatic denial that there is need for hand firing if the man in charge knows what he is doing, and in this connection it may be pointed out that machine-stoked dye-houses work without hand firing, and the dye-house load is admittedly more variable than even the electric power station load.

This objection is made by persons who have experience of stokers of 30 years ago, but cannot justly be made by persons who have recent experience. Thousands of stokers are now conveyor fed; these could not be easily hand fired in regular work, even if it were so desired.

5. Against this objection we have the fact that many mills with but one or two boilers employ these stokers, which they could not do if constant breakdowns were the order of the day. It is, at any rate, a general rule with my own firm, as also with others of equal standing, to guarantee a greater evaporation by 25 per cent. to 50 per cent. from any coal than that obtained by hand firing with the same coal.

(To be concluded.)

NOTES ON ALTERNATE CURRENT INDUCTION MOTORS.

By T. Harding Churton.

(*Abstract of Paper read before the Institution of Electrical Engineers, at Leeds, October 25th*, 1905.)

In this paper the author compares the performances and characteristics of induction motors provided with short-circuit and with wound rotors respectively, on single-phase and polyphase circuits, and indicates by comparisons, the extent to which the working of such motors is affected by the frequency, the particulars given being the results obtained from actual tests on a number of machines of the same size. The windings were, in each case, appropriate to the circuit upon which the motor was to operate.

When an induction motor is started up, the field of the stator starts at once to revolve at the full speed of the motor, and the rate at which it cuts the rotor conductors falls from a maximum when the rotor is at rest to a minimum when the highest speed of rotation is attained. The currents thereby induced in the rotor conductors lag behind the stator field, the difference in phase depending upon the strength of the currents, which will depend, of course, upon the resistance of the circuits. The field due to the rotor currents, reacting upon the stator field, which it consequently weakens, is also, of course, dependent upon the resistance of the rotor circuits. But the torque exerted by the rotor, being proportional to the strength of the stator fields and rotor currents, and inversely proportional to the phase difference between them, the maximum torque of the motor at a particular speed depends upon a certain value being given to the rotor resistance, which value decreases as the speed of the motor increases up to synchronism. For this reason, a motor provided with a rotor, into the circuits of which resistance may be inserted and gradually cut out as the motor gains speed, starts up better than one having permanent connections.

The maximum starting torque is obtained when

$$R_0 = R_2 \times \frac{n_1}{(n_1 - n_2)}$$

where

R_0 = total resistance of rotor circuits.
R_2 = ohmic resistance of rotor winding.
n_1 = frequency of stator currents (or speed of stator field).
n_2 = frequency of rotor currents (or slip of rotor).

In the case of two-phase or three-phase motors a considerable starting torque may be obtained with short-circuit rotors having conductors of comparatively high resistance. But such resistance seriously affects the efficiency, as well as the slip, of the motor when running on load, and motors so constructed are usually employed therefore only for intermittent work, such as, for example, operating cranes. When an induction motor is required to combine relatively high starting torque and high efficiency on load, it should have a wound rotor and variable starting resistance. If, however, so high a starting torque is not required, the short-circuit rotor, with low resistance conductors, is preferred on account of mechanical superiority, greater electrical efficiency and overload capacity.

If a polyphase motor of high efficiency with short-circuit rotor is switched directly on to the mains, with a periodicity of, say, 50 cycles, there will be a momentary rush of current equal to about three to five times full-load current, while the resulting starting torque will be about 2½ to 4 times full-load torque. If the pressure of the supply current is reduced by a transformer starter, the current from the mains may be reduced to, say, about full-load current, when the torque will be equal to about one-half to three-quarters full-load torque. With a wound rotor, a similar machine would give full-load torque with full-load current, and this current could be switched on gradually. As the rotors are invariably provided with a three-phase winding, the regulating resistance is always in three divisions. Liquid resistances are sometimes used, but more frequently wire or metal strip multiple-contact rheostats are employed.

The curves shown in fig. 1 are from tests taken upon two motors, one having a short-circuit rotor and the other a wound rotor, but which were in other respects identical machines. It will be noticed that both the efficiency and power factor are higher in the case of the machine with the short-circuit rotor. Both machines were constructed to give 5 B.H.P. at about 1,420 revolutions on a single-phase, 200-volt, 50-cycle circuit. The starting torque obtained with the short-circuit rotor machine was ·45 full-load torque with 1·25 times full-load current, while the wound rotor machine gave ·75 full-load torque with full-load current. The slip is somewhat greater with the wound rotor which would, moreover, pull out of step rather sooner than the short-circuit rotor. The difference between the results obtained with the short-circuit and wound rotors on polyphase working is practically the same as that on single-phase, though with the polyphase system the results themselves are much better, as will be shown later.

Speed regulation has been so far, perhaps, the least satisfactory feature of the induction motor. The insertion of non-inductive resistance in the rotor circuits has the disadvantage of being uneconomical, and a further objection is the instability of the speed with varying load. For many purposes, however, this method answers sufficiently well, and where the work is of an intermittent character, the question of economy is not, of course, of much consequence.

For some purposes, such as operating cranes, the short-circuit rotor with conductors of relatively high resistance, combined with graduated transformers for varying the voltage on the stator windings, is sometimes preferred for polyphase motors.

To compare, now, the performance of the motor on single-phase and on polyphase working, it must be remembered that the field produced in the single-phase motor is not a uniformly rotating field as in the case of a polyphase motor, and, therefore, motors

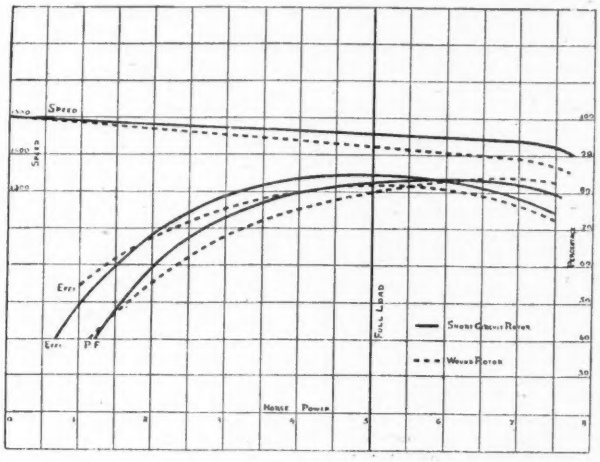


Fig. 1.

of this type have not nearly so good a starting torque on single-phase as on polyphase circuits. For the same reason, the maximum running torque and B.H.P. of the motor are less when working single-phase than polyphase, and the single-phase motor will, moreover, pull out of step and stop with less overload than the polyphase motor will carry.

Table I.

	Single-phase.		Polyphase.	
	Starting current.	Starting torque.	Starting current.	Starting torque.
Short-circuit rotor	1·25	·45	1·25	·75
Wound rotor	1	·75	1	1

Note.—The figures refer to the normal full-load values.

Table I. shows the performance of the motor with regard to starting torque and current on single and two-phase circuits of 50 cycles, 200 volts, and with short-circuit and wound rotors respectively. The superiority of the polyphase motor in this respect is clearly shown.

The curves in fig. 2 show also that the efficiency and power factor are higher in the case of the polyphase motor and that the slip is greater in the single-phase motor.

A great deal of attention has been paid to the methods of starting the single-phase motor, the principal object being generally to obtain as great a phase difference as possible between the currents in the main and starting coils.

The method of starting adopted by the author is to connect the main and starting coils in series and a non-inductive resistance across the starting coils, that is, in series with the main winding, to which it gives a lead, while the self-induction of the starting coil gives the current flowing in it a considerable lag. The auxiliary winding occupies about one quarter of the stator winding space, and is wound in the centre of the main poles where the main winding could not be usefully employed. It is usually wound with either one-half or twice the number of turns of the main winding. The author prefers the fewer number of turns on account of the otherwise high induced voltage continually on the windings tending to break down the insulation. In some makes of motors this risk of failure of insulation is still further increased by one end of the auxiliary coil being left connected to one end of the main winding,

in which case, the voltages of the two windings are in series. Thus, in a 200-volt motor, the voltage on the windings may be about 550 volts, depending upon the phase difference of the voltage in the windings.

The question of frequency is a very important matter with regard to induction motors. In the first place, the torque exerted by the motor is inversely proportional to the frequency of the

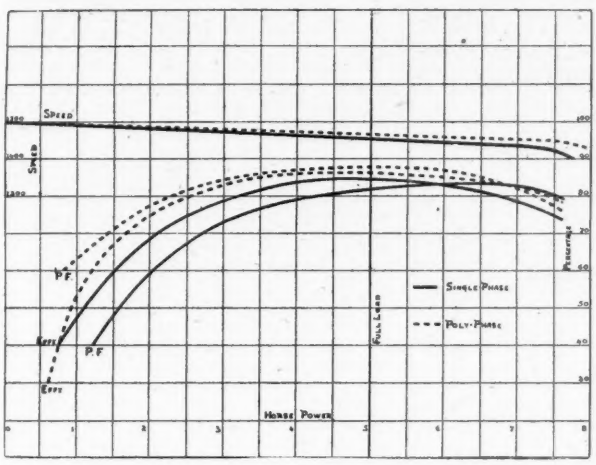


Fig. 2.

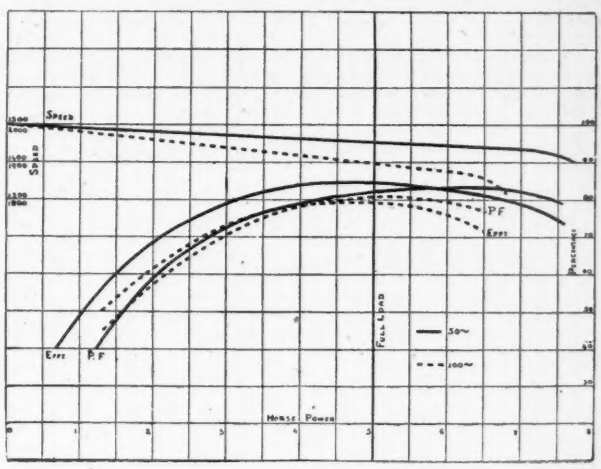


Fig. 3.

supply current. In order, therefore, that the motor may give the same maximum H.P. on 100 cycles as on 50 cycles, the speed must be doubled. The iron loss is greater at the higher frequency, and, other things being equal, the efficiency of the motor is therefore lower. The leakage coefficient being greater at the higher frequency, the power factor is lower, and this again, by increasing the currents, increases the C^2R losses, which therefore further reduces the efficiency. The hysteresis loss and leakage coefficient increase much more rapidly on the higher range of frequencies than on the lower. For example, the difference is much greater between 50 cycles and 100 cycles than between 25 and 50 cycles.

The curves in fig. 3 show the difference in the efficiency, power factor and slip of the same size of motor as before referred to when giving 5 B.H.P. on 50 cycles, at about 1,450 r.p.m., and the same H.P. on 100 cycles at 1,900 r.p.m. It will be here observed that the speed on 100 cycles is not, for the same H.P., double that on 50 cycles, as would have been expected from the statement above. But it may be explained that this was due merely to the exingencies of manufacture, the same standard stampings having been utilised in each case, and the windings varied to obtain the required output with the best results.

High frequency is not only prejudicial to efficiency, power factor and torque, but is particularly detrimental to good starting performance. This will be seen from Table II., which gives the starting torque and current of the 5-H.P. motor on 50 cycles and 100 cycles respectively.

It may be remarked that on circuits of 100 cycles, about twice the full load current is usually taken for starting short-circuited rotor motors, whereas on 50 cycles the starting current does not usually much exceed the normal full load current.

Table II.—Starting Torque and Current on 50 Cycles and 100 Cycles of 5-H.P. Motor (Short-circuit Rotor)—200 Volts.

Cycles.	Starting current.	Starting torque.	R.p.m.
50	1·25	·45	1,450
100	2	·43	1,900

In concluding these notes, a brief reference to the single-phase repulsion motor may not be out of place.

If a copper ring is suspended in an alternating field it tends to turn, so that its plane is parallel to the direction of the flux, in which position it does not enclose any magnetic lines. If placed with its plane at right angles to the flux, it will not move, the tendency to turn in one direction being balanced by an equal tendency to turn in the other. Midway between these two positions—that is, at 45° to the flux, the tendency to turn would be at its maximum, provided that the currents induced in the ring were in phase with the primary field. Owing, however, to the self-induction of the ring causing the currents induced in it to lag, the position of the ring that gives maximum torque is moved correspondingly forward. If, therefore, an ordinary direct-current armature is placed in an alternating-current field and the brushes given a slight lead in either direction and short-circuited, the armature (or rotor) will rotate. The function of the brushes is merely to short-circuit the coils as they successively come under the poles, and only those coils that are thus short-circuited are exerting a torque. The object of connecting the brushes together is—if the armature has a parallel winding—to equalise any irregularity of pressure, just as equalising rings are sometimes employed in multipolar direct-current armatures. If the armature is series-wound, the connecting ring is required to short-circuit the coils. The speed characteristic of such a motor is similar to that of a series-wound direct-current motor—it will race if run without load, and the torque exerted varies inversely as the speed, and is, therefore, greatest at starting. If the armature windings are suitably connected to three slip-rings, to enable resistance to be inserted at starting, which can be gradually cut out as the motor gains speed, the starting will be improved and the starting current reduced. The result of connecting the rotor windings in this way is that currents flow in all the conductors, thereby exerting a torque just as in an induction motor. As the speed of the rotor increases up to synchronism, the currents in the rotor come more into phase with those in the stator, and thus the torque due to this inductive effect increases with the speed. We have thus a compound effect which results in a gradual decrease of torque, from that due to the initial repulsion effect to the maximum running torque of the machine as an induction motor. For operating hoisting machinery, and many other purposes, such a motor is very well adapted. On a 50-cycle circuit, the starting torque may be as great as twice the full-load torque with less than 1·5 times full-load current, while three times full-load torque may be obtained at starting with about twice the full-load running-current; and if, when the motor has run up to speed, the slip rings are short-circuited, the motor will run practically as an ordinary induction motor. If the brushes are left on the commutator, they continue, of course, to short-circuit the coils, which, therefore, continue to exert a torque due to the repulsion effect and tend to race. On the other hand, the induction action of the remaining conductors tends to run the motor at synchronism. The result is, that when running light, the speed of the motor is a little above synchronism.

The efficiency and power factor of the repulsion motor are not quite so high as those of the induction motor; the current taken for the same horse-power, and on the same voltage and periodicity, being about 10 per cent. higher; and the horse-power of the motor is, roughly, 70 per cent. of that which it would be as a single-phase induction machine.

Reversing the direction of rotation may be effected either by shifting the brushes to the other side of the neutral position on the commutator, or by shifting the position of the poles themselves. The latter may be accomplished by employing two sets of windings on the stator, inclined to one another at the same angle through which the brushes would otherwise have to be moved. Either winding can, of course, be brought into operation by a simple two-way switch. The stator winding is switched directly on to the mains, and the starting current may be kept within the limits usually required by means of the regulating resistance in the rotor circuits.

The tendency to spark as the short-circuited coils leave the brushes has been a serious difficulty with the repulsion motor. However, if the reactance voltage is kept sufficiently low, and the machine provided with slip-rings—so that the circuits are not really broken—the difficulty of sparking may be quite overcome.

MANCHESTER ASSOCIATION OF ENGINEERS.

Mr. R. Matthews, managing director of Armstrong, Whitworth and Co., Ltd., at their Manchester Works, inaugurated his year of office as president of the Manchester Association of Engineers, by giving an address to the members on Saturday last. This being the fiftieth year of the Association's existence, he gave a brief retrospect of the changes and improvements in various branches of engineering within the half century. Leaving matters of history, the president dealt with German competition—a large and difficult subject, he said, and one which did not receive due thought or attention. This competition, which years ago was spoken of as a "German bogy," was a stern reality. To illustrate it, he had prepared a diagram showing the gross exports and imports of Great Britain along side those of Germany (which, unfortunately, only began with 1880), showing the more steady and rapid growth relatively of the foreign German trade over that of Great Britain. This was more apparent when it was borne in mind that to accomplish our trade we had had to export in capital or otherwise £2,000,000,000, against

the German £1,000,000,000, just one-half. When it was considered that so recently as 1887 the imports and exports almost balanced, the final success of the German achievement was the more remarkable. Germany's exports of her own produce for 1905 were estimated to reach about £270,000,000 against £325,000,000 of British exports. Such figures as these, brought about in such a short space of time, were most appalling. Had it never occurred to them how strange it was that their politicians and educationalists were everlastingly quoting the Germans as the most educated, and if that were so (and it might be confirmed by the successful business results), then why should they be so afraid to manfully examine and look into the miscalled free trade question?

Personally, he was a free trader, but when foreign competitors were injuring them by taking unfair advantage of their free trade policy, he thought it time to halt. When bad times came, the Germans and Americans could afford to dump, as the fair prices at home permitted them to compete at a comparative loss. They had a typical example in Manchester, when the Corporation were putting down the electric power plant. He had the refusal of the crankshafts for about 15 per cent. below cost price, so had to decline them. He asked them, as business men, where was the gain to this country in such a case, where they had the men idle, tools idle, and the material in the country, by placing this order in Germany?

Raw materials and food in many cases ought to be free from duty; but as there was no machinery which could not be made better in this country, he hoped before long to see labour insisting on all finished machinery and materials being subject either to equal reciprocal duties, or at least 15 per cent., which corresponds to our superiority.

Our foreign trade suffered largely from the non-commercial attachés at the British Embassies abroad, who could not condescend to anything so low as trade. Germany and other countries were represented by servants and officers of the highest standing, who made it their duty and pleasure to render business assistance to their fellow countrymen.

Dealing with the question of municipal trading, the president spoke of the excessive charges made by corporations for gas and electricity required for power purposes, and said:—

"A few years ago, being short of room, we wanted to drive our new shops electrically, but were asked 1½d. per unit; whereas on the Tyne from a private profitable power company, it can be obtained at half that price; and to encourage Manchester trade, if instead of hounding and prosecuting manufacturers for smoke nuisances, they assisted them by selling electricity for ½d. per unit, they would, like charity, be blessing him that gives, as well as him who receives.

"Does it not seem scandalous that in this so-called Free Trade city the people's money should be spent in opposing free and healthy competition (seeing that it is free from international complications) to give our City Fathers a monopoly and charge what they like, instead of the cost, thus enabling them to acquire large sums of money which can be used to hide their mismanagement and make the rates look low, thus indirectly encouraging extravagance?"

The closing part of the President's address was a discussion of labour difficulties. He expressed a hope that the better feeling between capital and labour which had existed since the century came in would long continue.

The cordial thanks of the meeting were given to the President for his address. Several other gentlemen spoke and expressed themselves fully in sympathy with the President's views on foreign competition.

THE OLYMPIA ELECTRICAL EXHIBITION.

(*Continued from page* 669.)

Foxcroft & Duncan.

This firm's excellent display of electrical instruments of many well-known types attracted a well-deserved attention on the part of the visitor; accuracy of workmanship being a prominent characteristic. An accumulator switchboard in white marble fitted with moving-coil instruments, the Crawley automatic cut-out, charge and discharge switches, &c., was also a noticeable feature on the stand.

The Easton Lift Co., Ltd.

Two of this company's lifts at the Exhibition fulfilled the very useful purpose of conveying tired visitors between the main hall and gallery, a function which in other situations they have most successfully and efficiently carried out for some years.

To mention only a few installations, the new Brighton Tower has four 300 ft. lifts, stated to be the highest electric lifts in existence; the City and South London Railway possesses 26, the Great Northern and City seven, the Houses of Parliament four, and the Midland Hotel, Manchester, 19 of these lifts, while they are scattered over the country to the number of over 1,000.

The Howard Conduit Co., Ltd.

The Howard Co.'s exhibit, although it arrived somewhat late in the day, was interesting on account of the novel features appertaining to the asphalt troughing in which the firm specialises. In addition to samples of the materials and tools used in putting down this class of conduit, two lengths of troughing were on view, demonstrating how easily it may be bent into a curve if warmed.

Numerous photographs illustrating the various contracts undertaken were shown; these included views of work on the G.W. Rly. electrified sections.

Dorman & Smith.

The principal feature of Messrs. Dorman & Smith's exhibit was the patent "grip-contact" circuit-breaker with which their name is associated, and which is already widely known and used. Various forms were shown, with overload reverse current and minimum voltage control, and the new Dorman & Smith Time Limit Relay, which we described in our issue of September 22nd last, was employed in conjunction with some of them.

The essential characteristic of this circuit-breaker is the fact that when opening or closing the contacts are only lightly pressed

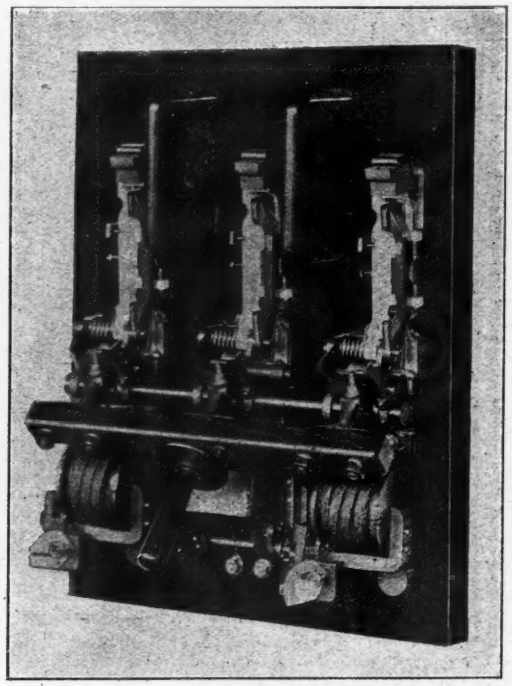


Fig. 129.—Three-Phase Overload and No-Volt Automatic Motor Switch.

together, so that there is no risk of sticking; but when the switch is fully closed, the contact faces are pressed together by a powerful gripping lever. The contact faces are kept clean by the rubbing action when opening or closing. A secondary switch is combined with the circuit-breaker; the latter must be closed first, after which, with the same handle, the secondary switch is closed, and as the circuit-breaker is entirely free to act at once, it is impossible to hold it in on an overload.

Besides the foregoing, the firm's main switches, switch fuses, ship lighting, and other heavy fittings, &c., were well represented.

The fuses shown covered currents from 1 to 500 amperes at all voltages up to 600 volts. Some of these fuses were also shown mounted in this firm's patent interlocking cast-iron boxes for house service use. Patent ceiling roses for conduit wiring systems, and a range of strong cast-iron fittings interchangeable with the roses, switches, &c., on the same series of standard cast-iron jointing boxes, were exhibited.

Messrs. Dorman & Smith also showed a circuit-breaker for three-phase motors, an illustration of which we give herewith (fig. 129). The whole of the gear is operated by one handle making one simple movement. It is provided with a tripping coil on two of the circuits, and a no-load or minimum voltage control is provided on the third phase, the central switch of the three. The operation of any one of the automatic controlling devices simultaneously opens all three circuits, or all three of the circuits are opened together by hand. Also, the three switches are closed together, and the no-voltage controlling device is automatically brought into operation by the simple movement of the single switch handle.

Siemens Bros. & Co., Ltd.

That we have refrained so far from giving Messrs. Siemens their just due, in regard to their exhibit, is attributable indirectly to the comprehensive character of the latter. The stand was excellently situated, and its contents included electrical motors of the polyphase and direct current types, together with examples of switch and controller gear for the varied applications of the motor. In the matter of lighting, the firm's well-known arc lamps were on view, and a well displayed exhibit of 100 Tantalum lamps added the touch of novelty to the stand.

The cable department showed specimens of lighting, telephone, and submarine cables adapted for every requirement, and a selection of miscellaneous apparatus, including small batteries, electric drills, pyrometers, &c., added to the varied features of the exhibit.

Among the machines on view, the 18 V induction motor, rated at 30 B.H.P. at 600 volts and 50 cycles was of special interest. It has a synchronous speed of 750 revs. per minute; an efficiency of 90 per cent. and power factor cos ϕ = 0·88. The

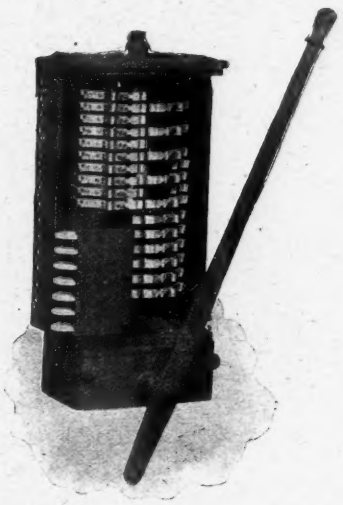


Fig. 130.—Three-Phase Crane Controller, Type F.

Fig. 131.—Siemens V-Type Induction Motor.

motor can be loaded with 2·3 times the normal full load torque without pulling up, and on account of its efficient ventilation the final temperature rise when run continuously at the above rated

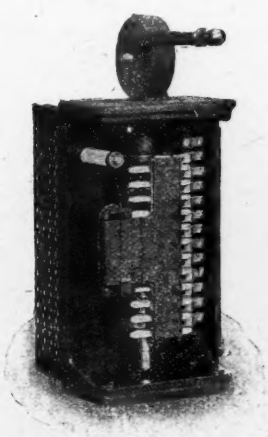


Fig. 132.—D.C. Crane Controller, Type H.

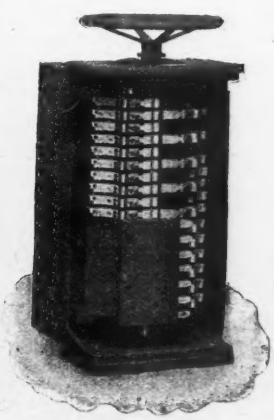


Fig. 133.—Three-Phase Crane Controller, Type A.

output is only 30° F. at the hottest part. This motor is fitted with a starting resistance, carried in recesses on the rotor casting, and connected to a three-pole multiple contact switch also carried on the rotor, and revolving with it. In starting the motor, the switch contacts are successively short circuited by a three-armed switch blade which is rotated relatively to the switch contacts by a mechanism which operates through a longitudinal hole in the shaft. This device does away with all necessity for external connections to the rotor, whilst it provides as efficient a means of starting as can be obtained with the normal slip ring type. This mechanism, illustrated in fig. 134, possesses several advantages over similar types of internal starters which have before been on the market, the principal of these being that the switch motion is controlled by a notching gear which gives an extremely definite step by step motion, and thereby prevents burning of the switch contact, and that the mechanism is also arranged so that there is no friction between the fixer and the rotating parts when once the motor has been fully started. An indicator is provided to mark the starting and running positions.

The gear is shown with the intermittent motion in its final position, *i.e.*, with all the resistance in the rotor circuit cut out.

In starting up, the position of the auxiliary plunger B is such, that the roller C engages with the vee-slot 1. As screw M is rotated by means of the hand-wheel L, it forces the bush E in the direction indicated by arrow. Bush E transmits this pull to the auxiliary plunger B, causing the latter to force back plunger F against the action of the spring G. The hand-wheel is slowly rotated until such a position is reached, that the action of the spring D overcomes the action of the plunger F, thus causing the plunger B to jump until the roller C occupies vee-slot 2. This movement is immediately taken up by plunger A under the action of plunger B.

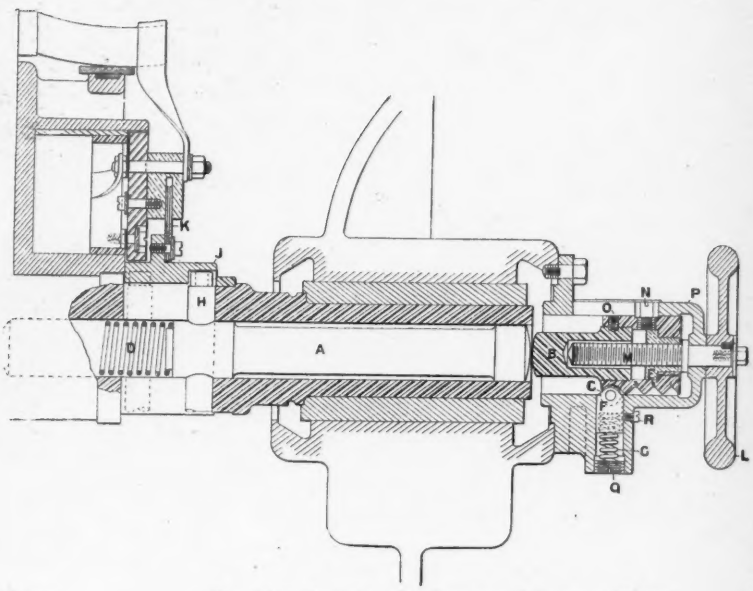


Fig. 134.—Internal Starter for Induction Motor.

Plunger A, in moving, carries with it the pin H, which, rolling in a spiral slot of collar J, gives to the latter a rotary motion. Collar J carries the blades, which intermittently short-circuit the three sets of contacts corresponding to the phases, one blade only being shown. If the hand-wheel L is still rotated, then the movement of plungers A and B are repeated, the roller C successively occupying vee-slots Nos. 1, 2, 3 and 4. The number of vee-slots corresponds to the number of resistance contacts, and the blade K occupies a definite position when the roller C is in any one of the vee-slots.

Various types of controllers were on view suitable for operating cranes, hoists, winches, turntables, gun turrets, &c., where the motions are frequently reversed and the loads intermittent and varying. Up to a comparatively recent period, simple controllers of the reversing and regulating type have been almost invariably used in this country and, in the majority of cases, have proved efficient and satisfactory. Owing, however, to the present necessity of dealing with heavier classes of work, the finer regulations of speed required and the growing demand for some form of control for quickly retarding the various movements, simple reversing controllers do not in all cases meet the actual requirements. Although by the reversal of the current they can be made to exert a braking effect, this method is bad for both the motor and controller.

The principle applied in Messrs. Siemens's controllers consists of an electric rheostatic brake, which is carried out by arranging the controller so that at certain predetermined points the motor, when driven by the load, shall act as a generator, the motion of the load being retarded as slowly or as quickly as desired by varying the resistance in circuit with the machines. By the adoption of this device the cost of a mechanical brake is saved, which is by no means a small item. It is, however, advisable where possible to provide a brake to hold the motor when the current is cut off. We illustrate in figs. 130, 132 and 133 types of Messrs. Siemens's controllers.

The Consolidated Pneumatic Tool Co., Ltd.

This firm are well known as manufacturers of the electric and pneumatic drilling machinery, and their exhibit at Olympia, illustrated both classes of plant. The electrical drills were shown

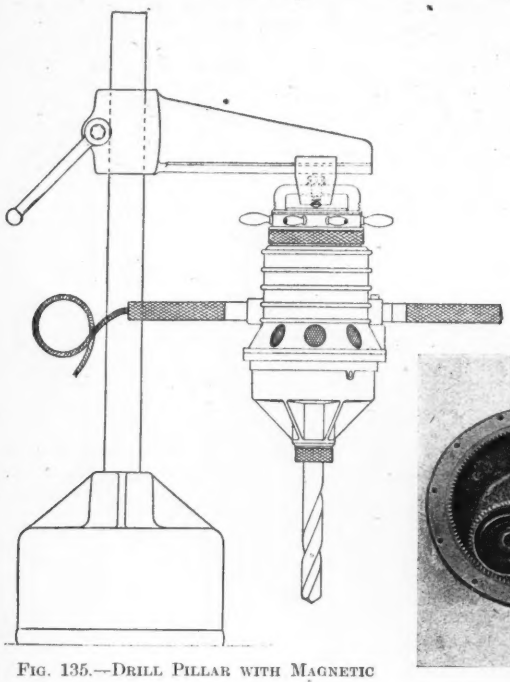


Fig. 135.—Drill Pillar with Magnetic Base.

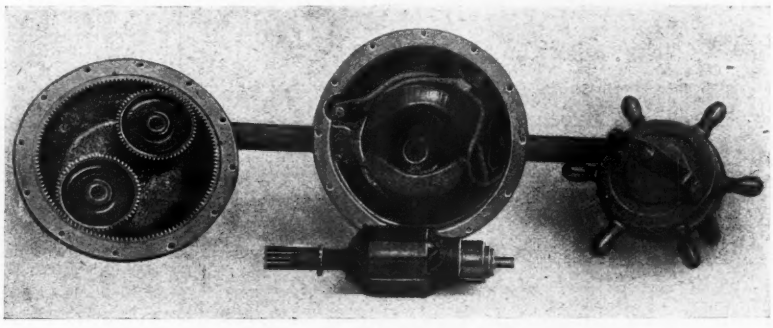


Fig. 136.—Details of Electric Drill.

in operation; the single motor drills are made in four sizes, for holes varying from $\frac{1}{2}$ in. up to $2\frac{1}{2}$ in.

A larger and more powerful drill shown, provided with three armatures gearing into a common drill spindle, was somewhat of a novelty; it is adapted for heavy work, but in the $1\frac{1}{4}$ in. size, only weighs 39 lb., and in the $2\frac{1}{2}$ in. size only 57 lb.

In fig. 135 we show a drill pillar fitted with a magnetic base, which renders it quickly adaptable in out of the way situations, for iron or steel constructional work.

Berry, Skinner & Co.

The whole of the power supply at the Exhibition, we understand, was controlled by Messrs. Berry, Skinner & Co.'s patent fool-proof ironclad switches and fuses; but this must not be taken to imply any reflection upon the competency of the exhibitors or their representatives! We have already described and illustrated this

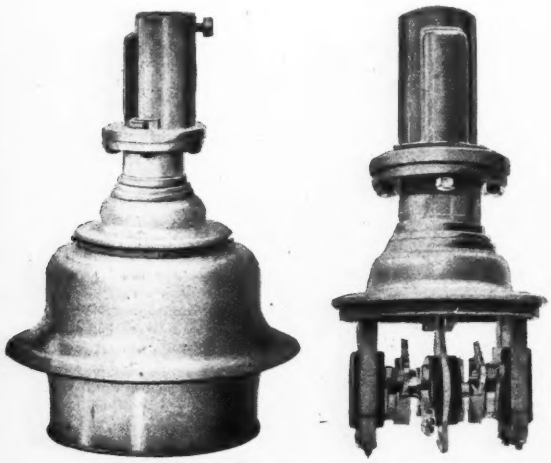


Fig. 137.—"Cam" Patent Arc Lamp Suspension.

apparatus, which is made double and triple-pole, and for voltages up to 2,000, and is remarkable for the simplicity of the construction, which makes it impossible to open the case with the switch on, or to close it with the switch in the on position, while the working parts are very substantial and well-arranged.

The "Cam" patent arc lamp suspension gear, which was shown, is illustrated herewith; for this, also, the fool-proof quality was claimed. By a neat and ingenious arrangement the contact plugs are positively guided into their correct sockets, and the alternate retention and release of the lamp are automatically ensured by very simple mechanical means. The gear is illustrated herewith; its action is independent of the skill of the operator, who has simply to raise the lamp as high as it will go, when its weight is automatically transferred from the rope to the gear. In lowering, the rope is hauled on again, when the lamp is at once released.

We described the Berry and Risch automatic isolating device for trolley wires in our issue of August 11th, 1905, in connection with the Tramways Exhibition; it was again shown, in much improved form, at Olympia. The apparatus is now so sensitive that it will cut off the main supply, in the event of a telephone or telegraph wire falling across the trolley wire, without blowing a 5-ampere fuse in series with the former. This result is attained by means of a specially delicate fuse, in which the fusible wire passes through a drop of nitro-glycerine! This, it will be admitted, is a distinctly novel idea.

The apparatus is in use throughout the Walthamstow electric tramways, and has been specified for 28 miles of the Johannesburg Light Railways by Messrs. Mordey & Dawbarn.

Other features of this interesting exhibit were a series of house-service cut-outs, tantalum lamps, various accessories, and the continuous concrete conduit, with which the firm's name has, for some two years, been associated.

W. G. Walker & Co.

The firm's patent concavo-convex fans, noted for their silent running qualities and simple construction, were the most noticeable feature of the stand. It is claimed that these fans, which were shown coupled direct to electric motors, have a very high efficiency and a greater output than many-bladed fans of similar size.

The firm were also exhibiting their small "fan" dynamometers.

Rawlings Bros., Ltd.

This exhibit consisted mainly of high-class drawing-room and other fittings—in the Louis and Empire styles—many of them actual fac-similes from original *objets d'art* treasured in museums. Beaten brass electroliers and other fittings of modern styles were shown in the gallery, where also a special system of wiring was on view. In this system, tinned brass conduits are used, with a special line of junction boxes, &c. Elbows are avoided as far as possible, smooth bends in the tube being preferred, and the latter is sweated to the junction and inspection boxes, so as to make the conduit electrically continuous and water-proof. The tubes are easily bent without filling, yet without deformation; they are fixed by means of saddle clips, to which they are also soldered. Owing to the small diameter of the tubes they can be laid in the thickness of the plaster without chasing the brickwork, and they make a very neat job. The cost of the material is about equal to that of screwed barrel, but the cost of erection is less. Owing to the smoothness of the interior the wires can be drawn in and out with ease, and without injury to the insulation; this is, in fact, a special feature of the system, and the operation of drawing wires in and out was demonstrated hundreds of times with the same wires at the Exhibition without abrading the insulation.

A letter appeared in our last issue in which Messrs. Rawlings Bros. pointed out that the system originated with Messrs. Handcock & Dykes, though the latter possess no financial interest in it.

The firm issued a leaflet at Olympia offering a complete country house installation of 8-c.p. lamps, comprising a petrol dynamo with accessories, storage battery, wiring and plain fittings, erected and guaranteed for six months, at a remarkably low inclusive price.

Stewarts & Lloyds, Ltd.

This firm showed a number of electric tramway steel poles, both tapered and in three sections, with mountings, brackets, &c. Lap-welded steel steam mains, with the firm's welded-on flanges, and a variety of other steam main accessories were exhibited, in addition to steel work of other descriptions. Perhaps the most interesting item was the famous Mephan Ferguson lock bar pipe, first used for the 30-in. Coolgardie water main, 380 miles long, and now adopted for power gas mains, pipe lines for hydro-electric power stations, &c., for pressures up to and exceeding 500 lb. per sq. in., and in diameters up to 5 ft.

Sir Hiram Maxim Electrical Co., Ltd.

This company's stand was brilliantly illuminated not only with glow lamps, but also with Maxim arc lamps; these are made semi-enclosed, for d.c. and a.c., and we understand that 800 of

them are in use on the Metropolitan District Railway, 200 on the L. & S.W. Rly., and 150 on order for the Baker Street and Waterloo tube. The "Cristalite" glow lamp, with ribbed bulb and opal reflector, and the "Marvel" lamp, designed to concentrate the light downwards, were on view; the "Brilliant" lamp is of the large-bulb type, and its cap is provided with a screw thread and nut to fix the shade on the lamp. A bayonet holder modified so as to carry shades fitted with a bayonet socket, a device for locking lamps securely in holders, and various useful applications of opal to lamp bulbs, formed parts of an exhibit of varied scope.

Oliver, Clark & Co.

A variety of electroliers, brackets, and pendants was exhibited at the stand of Messrs. Oliver, Clark & Co.; radiators, cooking apparatus, electric ironing, &c., were included in the exhibit, which was essentially arranged for the edification of actual, or would-be, consumers of electrical energy for domestic purposes.

Bruce Peebles & Co., Ltd.

Messrs. Bruce Peebles & Co. at first confined their exhibit to literary matter, a variety of occasional chairs, and a cosy corner; later, however, they showed the remarkable three-phase and direct-current motor truck which we mentioned in connection with the Tramways Exhibition, and of which a description appears elsewhere in this issue.

Maple & Co., Ltd.

The stand of this firm was tasteful and artistic, but was of interest to the consumer rather than to the electrical engineer. Some reproductions of old English china for lamp stands were noteworthy, and a variety of new fittings, bronzes, &c., was shown, of English and French designs. The Cooper electric tablecloth, of which the firm are sole makers, attracted much attention.

(To be continued.)

LEGAL.

William Rogers *v.* The Mayor and Corporation of Cardiff.

In the Court of Appeal on Friday, the Master of the Rolls and Lords Justices Romer and Mathew concluded the hearing of an appeal by the Mayor and Corporation of Cardiff, from an award made by the County Court Judge at Cardiff under the Workmen's Compensation Act, 1897.

Mr. Bailhache, who appeared for the appellants, said the claim had been brought in respect of an accident which happened to one of their servants on September 5th, 1903. The Corporation were owners of their own electric tramways, and William Rogers was employed from time to time in doing repairs to the overhead wires. To enable him to do these repairs, he drove a tower erection on a wagon. The man had to climb up this erection in order to get on a level with his work on the overhead wire. On the day in question he had been repairing some overhead wires in Cathedral Road, Cardiff. Having finished his work there, Rogers had to get to Duke Road in order to do further repairs. That thoroughfare was in another part of the burgh and some ¾ mile distant from Cathedral Road. When half-way between the two places, the horse bolted, and Rogers sustained injuries by getting entangled with the wagon. It was in respect of these injuries that Rogers claimed, and received, an award of compensation. The question was whether or not Rogers was engaged at the time on, in, or about any employment to which the Act of 1897 related. That question depended on Sec. 7 of the Act, and the definition of "railway" in that Act, counsel submitted, had led the learned County Court judge into an error in giving an award to Rogers.

At the conclusion of the arguments, the Master of the Rolls, in giving judgement, said he had come to the conclusion that the question in this case turned on the facts, and the County Court Judge had found the facts. Unless they found that there had been some misdirection which led the County Court Judge to find as he did, they could not interfere. The question in this case was as to engineering work, and it was only by referring to the engineering work as work undertaken by the undertakers, that they could be held liable for this accident. Engineering work did embrace a certain physical area, the expression pointing to there being local limits to the work; and the applicant must be shown to have been employed on in or about that area. The County Court Judge defined for himself the geographical limits, and found that the limits included the point where the accident happened. If it was not on the tram line it was in close proximity to it. In his opinion, there was evidence which justified the County Court Judge in considering that the area of the engineering work was co-extensive with the tramway itself. They could not define the area without seeing what the undertakers had undertaken to do. The County Court Judge found as a fact that the area as to which the obligations of the undertakers extended, was the whole area of the tramway, and that the applicant was employed by them to do such work as was necessary and obligatory on them as such undertakers. The whole work of repairing the wires of the tramway included the business of inspecting and ascertaining where the defects existed, and it was the duty of the applicant to ascertain defects and amend them. It seemed to him that the learned County Court Judge had, without any misdirection, arrived at the conclusion that the accident happened within the physical area of the engineering work. As this was a decision of fact which was not arrived at through the medium of any misdirection, the appeal failed. The Lords Justices delivered judgement to the same effect, and the appeal was accordingly dismissed with costs.

Osment *v.* Jenner.

On Tuesday last week in the Shoreditch County Court, before his Honour Judge Smyly, K.C., Arthur Wm. Osment, trading as Messrs. A. & H. Osment, of 101, Rendlesham Road, Dalston, N.E., an electrical engineer, sued Mr. E. Jenner, of 53, Borthwick Road, Leytonstone Road, Stratford, E., for £3 for electrical work done. Mr. Champion, for the plaintiff, explained that the work was done at a house in Fulready Road, Leyton, it consisting of finding a leak in the wiring, in consequence of which the Borough Council refused a service as the current ran to earth. The work was carried out accordingly, the leak found under some lath and plaster, and put right. The plaintiff was called, and bore out his solicitor's statement. It took a considerable time to find the leak, and all he had charged for beyond the hire of an O.K. meter, was 20 hours which the electrician took, whom he sent down, his fares, &c. The apprentice with the electrician he did not charge for. He was making about 15s. out of the transaction. The defendant contended that the claim was very excessive. He could have had the house re-wired for a less sum than the plaintiff wanted. He denied that 5s. a point was a low price, it being the ruling price in the district. His Honour said that he would give judgement for the plaintiff for £2 5s., and it seemed to him that he was getting a very reasonable profit for the work, at this price.

Lloyds *v.* Marconi Co.

In the Chancery Division Mr. Justice Kekewich has fixed November 21st for commencing the hearing of this action. According to the *Daily Mail*, witnesses will be brought from all parts of the country. It is stated that the Admiralty has intervened in the case, and that the Attorney-General will appear .

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession

A New Lease of Life.

A correspondent sends the following, with apologies and expressions of shame :—

[*It is stated that a large portion of the rolling stock of the Metropolitan Railway has been purchased by coal owners in South Wales to be used for the purpose of bringing miners to and from the pits.*]

We've toiled through fog, and smoke, and dirt,
Through tunnels dark and grim,
We've brought the worker to his work,
(Small thanks we've had from him).
"Your seats are hard, your pace is slow,
"Your fumes they catch my breath;"
All this we've heard for years and years,
It nearly caused our death.

But hark! What noise is this we hear?
What light dispels the gloom?
It is the swift electric train,
That tells our certain doom.
No more we'll burn our smokeless coal,
And waltz the Circle round,
Our part we'll play, by night, by day,
No longer underground.

But where! Oh, where shall we, from now,
Enjoy the air and sun?
Through field and wood, o'er bank and bridge,
Our daily courses run?
It is the far-off land of Wales,
Our waning strength requires;
The land which gave the coal that erst,
Burnt fiercely in our fires.

And what shall be the *rôle* which we,
Must play at second birth,
To ease the toil of those who grope
In darkness 'neath the earth.
And if in strenuous, earlier years,
We won no meed of praise,
The miner's blessing will adorn
Our latest, happiest days.

B.

Some Arithmetical Questions for Mr. Byng.

"A Foreigner's" remarks concerning Mr. Jaybee's letter are not very flattering to that gentleman, and to justify them he should have been more careful in choosing his arguments.

Like himself, I have seen and lived in several countries, and have found that quite a number of foreigners are of the same opinion as your correspondent, *i.e.*, that free trade is an excellent thing for England, but they rarely think that it would work quite as well in their native country. Should you doubt that they have England's well-being at heart, just change the topic from tariff reform to politics, and your mind will soon be at ease on that subject.

Now, as to "Mr. Foreigner's" remarks about the working classes in this country and abroad. The British workman gets the highest wages in Europe, and surely no free trader would have it that he pays more for his food and clothing than his protected fellow workmen do abroad. He, however, is "unable" to save up for rainy days; that much is evident from the terrible distress of the unemployed and from our overcrowded workhouses. Is this entirely due to the large amount of money he spends on the education of his children, or is it because he can't bear to see the poor publican starve, and thinks it his duty to encourage the Royal sport of horse racing, even though at a distance? If so, the Upper Ten are hardly to blame for his unfavourable financial position.

I fancy an English youth will have no more difficulty in finding employment, should he choose to emigrate, than citizens of any other nationality do, especially if he has availed himself of the opportunities offered to him at home, such as evening classes at the multitude of technical colleges which are nowadays as inexpensive and instructive as most similar institutions abroad.

Now, as to the University training, in which matter Germany is mostly held up as the shining light. In that country a student rarely matriculates many months before his 19th birthday. The course of electrical engineering at the Technical Universities is a four years' one, and one year's workshop experience is required, which, it is true, may be spread over the summer vacations. But hardly one in a hundred is able to get through the two branches in four years, and not a few take as much as 10.

The compulsory military service, if it is to be got through in one year, means another item of at least £100 to Herr Papa. Those whose parents cannot afford this must serve for two years, when the Government keeps them.

Furthermore, German students are hardly what would be called an economically minded body of young men, so that neglecting the expenses of the college fees, which are very small, the education of a German engineer is hardly the remarkably inexpensive matter many would have us believe.

As to the pride of English gentlemen, I always thought I was the son of one myself, and I happen to have been through the shops, and I should fancy there are a few more in a similar position.

The action of the L.C.C. has already been dealt with, but I should just like to point out that they teach in England that twice £38,200 is £76,400; so they do in many other countries. I should like to know what part of the world "A Foreigner" hails from?

Whole Hogger.

Kindly permit me to say one or two words in reply to "Foreigner" in the Review of last week. I am well acquainted with other countries, and the conditions of labour that exist there. I do not like to take exception to any remarks that may be made; but if I am the wreck on the open sea, I only hope, in my poor, crippled condition, I may foul a few of those brand new German liners laden with worthless rubbish, a great proportion of which, after arriving here, is taken out of the foreign-marked cases, recased and exported to the Colonies as British manufactures, bringing discredit on the manufacturers and mechanics of this country, and at the same time sanding the road for slightly better manufactured materials sent to them direct by these highly-educated foreigners. I do not know if my reading of the letter is a correct one; if so, it is surely a strong argument in favour of Protection, as, from the description he gives, the workmen in foreign countries enjoying protection are much better off than they are here. I think it is generally admitted by all sections in this country that there is something rotten, although they are divided as to the cause and the remedy. I have noticed one section, like their foreign friends, when cornered for an explanation of certain conditions, never fail to trot out the education bogy, probably because it contains arguments difficult to dispute. I do not believe, however, that the gentlemen that write our text-books have anything to learn from the self-opinionated foreigners, neither can I believe that the engineers and mechanics that make that beautifully finished and designed machinery made in this country have anything to learn from the men who make the rubbish that comes here from abroad. Stepping out of our own trade a little, are we to take it for granted that the men that can make Broadwoods, Brinsmeads and Chappells are out of employment, because they are so very ignorant compared with the men that make the pianos from the Fatherland, which are being dumped down in batches at the present moment at nearly every music shop in London? I think those men whose power of lung and words of praise fail them when speaking of the crowd of ignorant, dirty, "can't be too dirty" foreign wastrels, that are deposited at our docks every week, should be made to eat a leek when they tell our starving unemployed that nothing can be done for them, because they are so very ignorant, and before anything can be done, they must go and get educated. What of the cabinet trade, the men that could make chairs that would last a lifetime are out of work; we have chairs sent us now by the educated foreigner, and when you sit on them it is a puzzle for a moment to know whether you have dropped down on a chair or a roundabout. With reference to the remarks about the pride of English gentlemen, I have worked with the sons of foreign as well as English gentlemen, and in my opinion, there are no men in the world less assuming, and more willing to do whatever work is required of them, however dirty it may be, than the sons of English gentlemen; if any proof is wanting of this, refer to the Navy. I am in complete agreement with that portion of the letter which says "The best weapon a country can have is a good army of skilled workmen." If we are to have this we must find work, and when this is impossible the best thing we can do is to prevent the work being filched from them by unfair or dishonest means. If a lamp, switch, or any other article is made in Germany, *let the article be stamped and not only the packing case.* I suggest the formation of an Imperial Trade League somewhat on the lines of Freemasonry, with lodges in every town, to include all trades, not a political organisation, but simply for mutual benefit and protection between all for the good of all trades, an organisation which would draw in the present members of the different friendly societies, besides others. I think such an organisation as this would and could do more good than anything else for the promotion and protection of trade within the empire. I should be pleased myself with any promise of support to promote such a league; perhaps when the new babe showed signs of life someone more capable than I would consent to hold the leading strings.

Jaybee.

[We do not think that any useful purpose will be served by further correspondence on this subject.—Eds. E.R.]

Electric Cooking and Heating.

Mr. Dowsing in his lecture at the Olympia Exhibition laid the blame for the backwardness of the above to the high cost of energy; and he appeared very sanguine that, now that the majority of supply undertakings were going to supply energy for power purposes at 1d. per unit, electric cooking and heating was in for a boom. Mr. Editor, do not believe him.

I am afraid Mr. Dowsing is laying the blame on the wrong shoulders; the supply authorities are not at fault. Who can afford to fit up a kitchen when the cheapest kettle on the market is listed at 24s.? Then take Mr. Dowsing's own products. Who can afford electric radiators at £4 4s.? Very few can and will do this.

Repairs are also a heavy item. To repair an electric kettle recently cost me 10s.; to replace a lamp in a radiator

costs 5s. I am, of course, giving list prices; that is what the consumer has to pay.

Mr. Editor, it is not the supply authorities who are the laggards; it is the manufacturers of lamps and apparatus that are, and probably will remain, the drag until foreign competitors step in and seize the bulk of the work.

Cannot the Electrical Review stir these gentlemen up a little? At half the present list prices, things would boom and the manufacturers could still fill their pockets.

E. Stanley Harpham.

Finchley, *October* 31*st*, 1905.

Nameless Wire.

We are still in need of a name for a wireless telegraphy message. I suggest that it be called a "coni," or "coney," after Marconi. Thus, instead of saying "I sent him a wireless telegraphy message," we could say "I sent him a coni," or, "I conied him."

Frank Foster.

Manchester, *October* 25*th*, 1905.

[With all humility, and due deference to the great minds which have laboured with this problem, we venture to suggest that (1) A message transmitted by wireless telegraphy be called a "telegram." (2) The corresponding verb be "to telegraph."—Eds. E.R.]

The N.P.L. and Its Duties.

Referring to a leader in your issue of the 13th upon Dr. Glazebrook's communication to *The Times Engineering Supplement*, will you allow me to demur to your summing up the position by stating that Dr. Glazebrook's intentions are good, but were only stated undiplomatically. On the contrary, his intentions are anything but good, not only to the laboratory he directs, but to the large section of professional men he proposes to displace.

The National Physical Laboratory will find its time fully occupied in preparing and publishing standard methods of testing the innumerable materials used in the technical industries, and it is a great disappointment that the result so far is only a superfluous publication of stale information.

Surely, before he institutes another huge department to deal with the actual testing of materials and apparatus, in competition with many hardworking and able chemists and consulting engineers, he should at least first discharge the obligations imposed by the foundation of the laboratory.

Rumours are already circulating that the operations of the N.P.L. will be still further extended, even to the Law Courts, and it will be interesting to know the views of those professional bodies, who subscribe to the funds of the laboratory, upon these contemplated departures.

It is not too much to assume that the object of these extensions is further grants of public money to this laboratory, a very laudable desire, no doubt, on the part of the director and his "brilliant" staff, but hardly better, and certainly not less sordid, than the vulgar desire for profit of the ordinary professional man.

£ s. d.

Hygienic Telephones.

Having noticed with interest the letters of your correspondents on the above matter, perhaps you will permit me, as a purely disinterested writer and incidentally as a telephone expert (having no desire to give anyone the favour of a free advertisement, as one of your correspondents bluntly put it), to throw some fresh light on this matter.

Whatever subject has been broached in the columns of the Review, I have noticed for a number of years the fairness and impartiality of the Editors in giving as far as possible in such matters both sides of the case.

First, then, the idea of a purely hygienic telephone is to prevent as far as possible the accumulation in the mouthpiece of the microphone of moisture and dirt, and, as in the case of a telephone used by a large number of people, the harbouring of pathogenic germs capable of introducing disease into the human system.

This being so, which would a disinterested customer choose, a mouthpiece of a fairly accessible nature which could be easily cleaned, or a long, deep and narrow mouthpiece which serves in the new hygienic telephone as a handle also, which is not half so accessible as an ordinary mouthpiece, and which would under the proper conditions become a species of culture tube for the germs to disport themselves in and to multiply on the face of the globe—no, I mean mouthpiece?

The ordinary receiver ear piece is an equally ready means of infection, but this appears to have reached perfection from the point of view of accessibility.

Then there are one or two points, of minor importance, I suppose, as they only touch on the matter of priority in the design or invention of the hygienic telephone.

If any of your correspondents who are most interested in this matter will refer to our British Patent Office Records, they will find that on March 21st, 1903, Johan Holmström applied for a patent on this particular telephone, also that on April 17th, 1900, Messrs. Kneale & Hartley applied for a patent on a similar instrument, both cases being characterised by the handle mouthpiece and the adjacent design of microphone and receiver.

In view of the large extent to which the telephone is coming into use in modern life and its probable vast increase in the near future, the cleanliness of the telephone will have to be considered from a commercial point of view more than it has been hitherto.

Thanking you for your courtesy in permitting this side of the question to appear.

Alfred V. Newell.

Leicester, *October* 31*st*, 1905.

[We hold no brief for either side.—Eds. E.R.]

Ignition Gear for Gas Engines.

I shall be glad if any of your readers can tell me the name and address of the makers of the Lodge apparatus which was mentioned in the Review some time ago.

A. W.

St. Helens, *October* 31*st*, 1905.

The Electro-Deposition of Copper.

I have seen Mr. Ellis's letter of October 27th in reply to my letter. I do not think he makes the matter quite clear, as I understand on good authority that a large number of tubes produced at the Elmore Works are made by an American process of drawing. I should, therefore, be glad to learn whether the shells from which these tubes are drawn are from copper electro-deposited by the Elmore process, or from shells electro-deposited by the Elmore burnishing process.

Sherard Cowper Coles.

Westminster, *October* 30*th*, 1905.

Regenerative Control.

In view of your invited discussion, it may interest your readers to know some steps that have been taken with regenerative control for storage battery-driven electric carriages.

The cars experimented with were primarily fitted with an ordinary three-speed series-parallel controller, two series wound motors, and 44 to 48-cell battery. The running E.M.F. varies from 88 to 94 volts; average amperes on the flat, 30-35 amperes. The first attempt was a separately excited field control, and was not successful owing to the exceedingly heavy starting currents required. Then a mixed control, consisting of three series and four shunt speeds was tried. The series speeds were used to start the car only, but again the shunt fields took a small current, but the armatures took an enormous amount during the periods of acceleration. After some consideration another attempt was made, this time with more success. The control was seven speeds: three series; one shunt fields; one armatures parallel but fields in series; two armatures in parallel and fields in series, and in series to each other with a shunt across field circuit. This was very successful, and is still running now after a good many months without repair, nor are the commutators blackened or burnt in any way.

F

But since this car has been running, an improved type has been made, consisting, as before, of seven speeds, of which two are shunt speeds and the remainder speeds with series characteristics. A short description of this may not be out of place.

The controller is vertical and has 12 brushes for meeting the drum contacts. The drum is of the ordinary barrel type operated by one handle, for seven forward speeds and two reverse speeds. The drum contacts are six in number for all forward speeds and four for reverse speeds, and are cut out of solid metal. There are, of course, no breaks of the circuit on any of the series speeds and only in two places on the shunt speeds. The contacts are all fitted on the surface, and there are no cross connections embedded in the drum, thus making replacement an easy matter if necessity should arise. On the first speed the fields are in series with the armatures in series, thus making two series motors, and have a small resistance in circuit. On second speed this resistance is cut out; on third speed the fields in series with a resistance in circuit are in shunt to the armatures in series, thus making two shunt motors in series. The fourth speed is as the third, but has more resistance in field circuit. The fifth, the fields are in series and in series to the armatures in parallel. The sixth and seventh have low resistance shunts partially short-circuiting the fields, giving a light field as in a shunt motor, but preserving the series characteristics. With regard to regeneration, some very fine results have been achieved both in pulling up on the flat and in running down hill. Of course, in both cases the third and fourth, or shunt positions, are used. Pulling up on the flat as in traffic, from 30 down to 10 amperes can easily be had although not sustained, but down hills of varying gradients regeneration is kept up, varying from 25 to 10 amperes, according to the steepness of the hill and the initial velocity of the car.

The controller is practically sparkless, as the whole of the resistances can be used for breaking the circuit, and the space factor is also small, because there is no necessity for breaking the circuit at each step. It will be noticed that the fields of the two motors are in series the whole time, and that changing is effected principally on the armatures. There seems to be no trouble with the commutators. Carbon brushes are used. A remarkable result is that the pneumatic tires of the car do not either blister or wear to any extent, compared to an ordinary series controlled car. The pinions and gear generally, needless to say, wear much longer and are silent, due to gradual acceleration and absence of shocks and jars.

R. H. C. B.

Lead-Covered Wiring.

The statement of your correspondents, Messrs. H. Bailey and Co., in the current issue of the REVIEW, that they "only use vulcanised wire on installations where it is specified," prompts the subscriber to draw attention to a very common failing to which, as a rule, specialists in any particular system of wiring are peculiarly liable, viz., the indiscriminate installation of that system on every contract with which they are entrusted.

No doubt twin lead-covered paper-insulated cable possesses many advantages for house wiring, and dry and unexposed situations generally, but its use should be confined to this class of work.

The subscriber has now under his control an installation in a large foundry which was carried out a few years ago on the system referred to, and the greater part of it has had to be entirely re-wired owing to the destructive action of the foundry gases on the unprotected lead covering. Similar cable used for wiring outdoor arc lamps has had to be replaced for the same reason. A faulty section of this cable is forwarded herewith.

A calico print works' installation with which the subscriber is acquainted was wired on a similar system, but with V.I.R. insulation, and here also the lead covering did not last for any length of time. The installation in both cases was carried out by firms who were specialists in lead-covered wiring, and there is no reason to doubt the quality of the workmanship.

Before adopting this method of wiring, it is, therefore, advisable to consider each case on its own merits. Twin lead-covered V.I.R. cable makes a much better job; it is extensively used in ship lighting work, and the subscriber has several installations of this kind under his control which are satisfactory in every respect.

Engine and boiler rooms, however, are wired with single vulcanised cables run in screwed tubing, and in those parts of the ship exposed to the weather, twin cables are protected by a covering of wire armour yarned and compounded overall.

A valuable paper on the electric wiring of buildings by Mr. W. A. Chamen, with an interesting discussion thereon, is to be found in the *Transactions* of the Institution of Engineers and Shipbuilders in Scotland, Vol. 43.

George Stevenson,
Electrical Engineer for Carron Co.

Carron, Stirlingshire,
October 30th, 1905.

THE BRITISH SCIENCE GUILD.

On Monday, at the Mansion House, the inaugural meeting of this Guild was held, under the presidency of the Lord Mayor. Many leading scientists, manufacturers, and other men of eminence in various departments of life were present on the platform, and a number of interesting speeches respecting the objects of the Guild were delivered to an appreciative audience. The proceedings were opened by Sir Norman Lockyer, who explained the causes which had led up to the formation of the Guild, and the work it hopes to accomplish. The need was that all our national activities, State service, and private service should be conducted under the best possible conditions, with the greatest amount of brain power. Therefore it was not a question merely of science and scientific men. The Bishop of Ripon, in an eloquent speech, moved the election of the Rt. Hon. R. B. Haldane as first President of the Guild, and among other things that he said was this: That our manufacturers had been content to go on in jog-trot ways, without watching how far knowledge had advanced beyond them, to the detriment of themselves and of the consumer. The motion was seconded in a few words by Lord Strathcona, and supported by Sir Wm. Mather, who showed himself to be in disagreement with the views expressed by the Bishop of Ripon upon the condition of this country in comparison with others. He said he had some recollection of England being highly scientific and highly competent in certain fields of manufacture. We had in many of our industries the most brilliant scientific methods and processes. There was plenty of science in England; the trouble was that the people of England had not been trained to enable them to use largely the methods and principles of science which the peoples of other countries—not the select men—possessed. He had just returned from a four months' stay in the United States, and he found that the whole tendency and trend of American thought and feeling were to take masses of their young men and train them so that they might take their part as workers in their industries, not as managers, employers, capitalists, and so on. The resolution was carried unanimously, and Mr. Haldane acknowledged the honour in a most interesting address, which we have not space to dwell upon now. Speeches by Mr. C. W. Macara, Admiral Sir Cyprian Bridge, Sir J. Wolfe Barry and others followed. A lengthy list of vice-presidents and officers was appointed and a large general committee elected.

We can best describe the objects and organisation of the Guild by quoting the official announcements:—

1. To bring together as members of the Guild all those throughout the empire interested in science and scientific method, in order, by joint action, to convince the people, by means of publications and meetings, of the necessity of applying the methods of science to all branches of human endeavour, and thus to further the progress and increase the welfare of the empire.

2. To bring before the Government the scientific aspects of all matters affecting the national welfare.

3. To promote and extend the application of scientific principles to industrial and general purposes.

4. To promote scientific education by encouraging the support of universities and other institutions where the bounds of science are extended, or where new applications of science are devised.

The official pronouncement respecting the Guild's aims also says:—

"The Royal Society and British Association were founded for the promotion of natural knowledge; the Society of Arts for the encouragement of arts, manufactures, and commerce. The Science Guild, though in sympathy with these objects, is not identical in aim with any existing society. The promotion of natural knowledge is outside its sphere. Its purpose is to stimulate, not so much the acquisition of scientific knowledge, as the appreciation of its value, and the advantage of employing the methods of scientific inquiry, the study of cause and effect, in affairs of every kind. Such methods are not less applicable to the problems which confront the statesman, the official, the merchant, the manufacturer, the soldier, and the schoolmaster, than to those of the chemist or the biologist; and the value of a scientific education lies in the cultivation which it gives of the power to grasp and apply the principles

of investigation employed in the laboratory to the problems which modern life presents in peace or war."

Communications may be addressed to the Honorary Secretary of the British Science Guild, 16, Penywern Road, London, S.W.

BUSINESS NOTES.

Earl's Court Naval Exhibition.—In connection with the Naval, Shipping and Fisheries Exhibition, Earl's Court, which has just closed, the Stirling Boiler Co., Ltd., have been awarded a diploma and gold medal for their exhibit, which included a marine Stirling boiler, of 280 H.P. Part of the casing was removed to show the arrangement of the drums and tubes in the boiler. A special feature in the boiler was that it was lined with diatomite brick. This brick caused considerable interest in that a great advantage is claimed for it over ordinary firebrick, it being a much more efficient non-conductor and at the same time only one-seventh of the weight. The various tube cleaners used for cleaning the tubes of Stirling boilers were also on exhibition. One of the tubes was split from end to end and a turbine cleaner inserted, thus showing how this cleaner is worked. Similar boilers to that exhibited are at present in service in merchant vessels and shallow draught steamers, &c.

German Imports and Exports of Electrical Machinery.—So far this year there has been a slight increase in the exportation of electrical machinery from Germany, the returns for the eight months ending with August last showing a total of 8,849 tons, as compared with 8,584 tons in the corresponding period of last year. There has also been some advance in the importation of foreign electrical machinery into Germany—from 864 tons in the first eight months of 1904 to 960 tons in the eight months ending with August last.

Increase in Prices.—The Electrical Power Storage Co., Ltd., notify that from November 1st, 1905, all prices in their catalogue for complete cells, renewals and plates have been increased 5 per cent. The increase has been necessitated by the continued advance in the prices of raw materials, especially lead, during the past few months. This increase applies to all outstanding estimates.

Widnes and Runcorn Transporter Bridge.—Referring to our recent article on this bridge, it is interesting to note that the whole of the main steel wire suspender cables, subsidiary cables, and vertical suspension cables were manufactured and erected by the St. Helens Cable Co., Ltd., whose activities are not confined to electrical manufactures. The main suspender cables are about 1,650 ft. each in length, and 10½ in. in diameter, and their combined breaking strain approximates to 9,000 tons. Each of these cables consists of 19 parallel sections, 2·1 in. in diameter, containing 127 wires of No. 8 S.W.G., and having a breaking strain of 95 tons per sq. in.; thus the whole cable consists of 2,413 wires. The individual wires in the cables are laid without weld or joint from end to end, and are of equal length and tension, thereby ensuring uniform distribution of the load throughout. Before stranding, every wire was tested at each end, to comply with a series of tests required by the engineers, as also were the complete sections of cable. Since the erection has been completed the main cables have been thoroughly protected by special bitumastic compound, also manufactured by the St. Helens Co., and finally entirely encased in a double envelope of sail cloth treated with the same preservative.

Belgium.—The report of the Société Liégeoise d'Electricité, of Liége, for the last financial year shows a profit of £11,320, as compared with only £7,520 in the preceding 12 months.

Brush Contracts.—The Brush Electrical Engineering Co., Ltd., has booked the following contracts:—

For the County of Durham Electric Power Distributing Co., ten 300-kw. transformers.

For Messrs. J. Howden & Co., Glasgow, one 150-kw. dynamo.

Bankruptcy Proceedings.—H. J. C. Somerville.—The first meeting of creditors was held last week at the London Bankruptcy Court under the failure of Henry J. C. Somerville, 109, Victoria Street, Westminster. The debtor has been engaged in the promotion of various companies, included in the number being the Otto Electrical Manufacturing Co., Ltd. He held some shares therein, but places no present value upon them. Mr. E. S. Grey, Official Receiver, reported that the statement of affairs had not been lodged, but the debtor roughly estimated his liabilities at £4,000 and his assets at £1,150. He attributed his failure to recent ill-health, which prevented him from earning sufficient to pay off the claim of the petitioning creditors; to the collapse of various companies in which he was financially interested; and to liability of over £1,000 for law costs. It was intimated that the debtor hoped to submit an offer to the creditors, and by general consent the meeting was adjourned for a week.

Alexander Holland (Electrical and Mechanical Engineering Co.), Farnworth.—First and final dividend of 6d. in the £, payable October 28th, Official Receiver's office, 19, Exchange Street, Bolton.

Thomas Hill, electrical engineer, 24, Vicarage Road, Wolverhampton.—The Official Receiver (Mr. S. Wells Page) has issued a statement of the affairs of the above debtor, which shows his gross liabilities to be £178 3s. 6d., due to 22 unsecured, all of which is expected to rank for dividend. The assets are estimated by debtor at £13 11s. 2d., including £10 deposited with solicitor for costs of petition, and £3 11s. 2d. for good book debts. The deficiency is £164 12s. 4d. The causes of failure, as alleged by bankrupt, are "depression in trade, bad debts and loss on contracts."

Dissolutions and Liquidations.—Empire Telephone Co.—Messrs. E. Hahner and Max Wolff (telephone importers, dealers and erectors), have dissolved partnership. Debts will be attended to by the said Elizabeth Hahner.

Nunn, Watts & Co.—Messrs. T. R. B. Nunn and F. H. Watts (electrical engineers, 82, Mark Lane, E.C.), have dissolved partnership. Mr. Watts will attend to debts and continue the business under the same name as hitherto.

Delafone Batteries Syndicate, Ltd.—Creditors were to send particulars of their debts, &c., to the liquidators (Messrs. E. Williams and C. B. Hahn, 12, Norfolk Street, Manchester) by November 2nd.

Tin Electro-Smelting (Zinnoxyd) Co., Ltd.—A meeting is to be held at 9, Wool Exchange, Basinghall Street, E.C., on December 4th, to hear an account of the winding-up by the liquidator (Mr. A. le Clerc).

Land for Sale.—Land suitable for the erection of electrical engineering or motor-car manufactories is being offered for sale. It is situated within seven miles from London. Some particulars appear among our advertisements to-day.

Electric Clocks at Olympia.—We are informed by the Synchronome Co. that they have arranged with the authorities to leave their time-circuit of 20 electrically-propelled dials for the benefit of the visitors to the forthcoming Motor Exhibition at Olympia, and for the convenience of the management. Those who did not see this installation at the Electrical Exhibition will, therefore, have another opportunity of inspecting an up-to-date example of the modern method of time-keeping.

Mechanical Stoking.—The Hever Castle Power Station, Hever, Kent, has just arranged for an installation of four "Bennis" stokers and natural draught furnaces for its Lancashire boilers. The Midland Electric Corporation for Power Distribution, Wolverhampton, has placed an order for three stokers and compressed air furnaces for a water-tube boiler. The economies and other advantages claimed to result from machine-firing were recently given in a paper read before the Keighley Association of Engineers, Keighley, by Mr. A. W. Bennis. A free copy of the "lecture," which is now reprinting in our pages, may be obtained on application to Messrs. Ed. Bennis & Co., Ltd., Little Hulton, Bolton.

Catalogues and Lists.—Messrs. Alley & Maclellan, Ltd., Sentinel Works, Glasgow.—Illustrated circular No. 153, showing good half-tone views of representative examples of the "Sentinel" two-stage intercooling air compressors, and giving a list of users of these plants, including 13 machines for the Admiralty for various dockyards.

Messrs. Reid, McFarlane & Co., Ltd., 7, Graham Road, Plaistow, London, E.—Catalogue of Diatomite, Maxonite and asbestos compositions for boiler covering, also asbestos rope for pipe lagging, removable sectional coverings, non-conducting dry hair felt. A lengthy list of firms, ships and public buildings where these specialities are employed is given.

The Electric and Ordnance Accessories Co., Ltd., Stellite Works, Birmingham.—A number of new illustrated and priced leaflets. One describes the Stellite controllers for cranes, machine tools, &c.; another (L 21) particularises the "Stellite-Gradual" magnetic motor starter and regulator; a third (M 260) details the Stellite portable electric drills and appliances connected therewith; while a fourth (S 202) gives full information relating to watertight, gas-tight and dust-proof bells, signalling apparatus, &c., (Mercier's patents) for mines, collieries, factories, and so on.

Mr. C. R. Heap, 28, Hatton Garden, E.C.—Lists No. 10 and No. 11, issued by Messrs. Hodgson, Wright & Wood, the former giving specification and table of prices, weights, &c., of shunt-wound continuous-current protected motors, and the latter, shunt or compound-wound dynamos in the same way. Mr. Heap has also sent us a list illustrating and describing the "Case" controller.

Messrs. Carrick & Ritchie, Waverley Engineering Works, Edinburgh.—Newly issued catalogue of turbines, Pelton wheels, and other water motors. The firm, it hardly needs saying, has been pre-eminent among manufacturers of water-power plant for long years past. The "Waverley" and the "Girard" types of turbines are fully dealt with in this catalogue, descriptive notes and tables of sizes, powers, and prices appearing for single and double discharge, high-pressure double discharge turbines, Pelton jet waterwheels and water motors, and so on. Turbines for electric lighting and power transmission, sluice valves, turbine governors, and many other special departments of hydraulic engineering come in for treatment, and several pages are devoted to "useful information" on such subjects as measurement of water powers, loss of heat from friction in pipes, storage of water, and data for hydraulic calculations. A long list of users of Carrick & Ritchie plant, and selections from testimonials, are printed. We should not wonder if the list of users of such turbines for electric lighting purposes came as a revelation to some present-day engineers.

Messrs. H. W. Sambidge & Son, Highgate Street, Birmingham.—Two catalogues of electric light fittings, including many very artistic designs of brackets, pendants, standards, and the like.

The Worthington Pumping Co., Ltd., 153, Queen Victoria Street, E.C.—New catalogue of air and gas compressing machinery. In the course of 175 pp. a great deal of information, accompanied

by many excellent illustrations, is given relating to the different patterns of Worthington compressors. Much tabulated information is embodied in the book, and in addition to the descriptive matter relating to the compressing machinery, there is a good deal of useful general information of engineering interest. Those interested in compressors will find the book of considerable service. Another Worthington publication, also just to hand, deals fully and exclusively with the company's turbine pumps.

Trade Announcements.—The Direct Spanish Telegraph Co. has opened an office in Glasgow at 5, Royal Bank Place.

Mr. Robert E. Williams, late with Messrs. H. T. Boothroyd, Hyslop & Co., Bootle, Lancs., has now joined the firm of Messrs. Stafford & Co., mechanical and electrical engineers, of 117, Oxton Road, Birkenhead, where business will be carried on under the same style. Messrs. Stafford & Co. have just completed an entirely new installation of electric light at the New Theatre Royal, Birkenhead.

The British Empire Motor Trades Alliance has been registered as a limited liability company.

We understand that from August 1st, 1905, Mr. A. Steiger, of 28, Victoria Street, Westminster, S.W., ceased to act as representative to the firm of Escher Wyss & Co., Ltd., of Zurich, and the latter firm have entered into an arrangement with Mr Jens Orten-Boving, of 72, Victoria Street, Westminster, to represent them in the United Kingdom and all British Colonies. Mr. Boving has been connected with the firm's business for some years. We learn that many of the firm's well-known specialities will henceforth be manufactured in this country.

The City Corporation and Electric Lighting.—In view of the recent action taken by the City Corporation relative to making certain experiments with gas for street lighting, as a substitute for electric arc lamps, it is of interest to mention again the fact that was reported in our last issue, that at a meeting of the Court of Common Council held on Thursday, October 19th, a recommendation was made by the Markets Committee, and was adopted, that the whole of the lighting of the foreign cattle market, Deptford, which for some years past has been effected by gas and oil lamps, should be replaced by electric lighting by means of arc lamps throughout. Tenders were obtained to a specification prepared by Mr. S. G. Castle Russell, M.I.E.E., consulting engineer, and Mr. Horace Dove, F.I.A., chairman of the Markets Committee, is to be congratulated that he has not allowed his committee to take what undoubtedly would have been a retrograde step, but has guided them in the right direction. Messrs. Lund Bros. have secured the contract for carrying out the whole of the work required, which will include 218 Veritys' Aston-Worsley patent twin carbon enclosed arc lamps, arranged, roughly speaking, in equal numbers alternately connected to the mains of the London Electric Supply Co.'s Deptford station, at a pressure of 210 volts for the alternating circuits, and 460 volts for the continuous. There is also a scheme for incandescent lighting. Judging from this decision, the gas experiments recently made in the City have evidently not impressed the City Fathers very favourably as a whole, and if fair consideration were given to the matter, electricity would not be supplanted by gas at all. Our readers have only to compare the pressure gas lamps, which light the gutter admirably, with the arc lamps installed throughout the City generally, which, without doubt, light the streets.

For Sale.—The plant and stock of the Stanley Electric Carriage Co., Ltd., Church Street, Chelsea, is being offered for sale by tender.

The Alleged Electrical Frauds Case.—On 26th ult., at the Guildhall, John Bell, William Leslie, Thomas Rosenberg, George Webber and Frances Cheeseman were committed for trial on the charge of fraudulently obtaining sums amounting to £30,000 from a number of electrical firms.

Book Notices.—"Elementary Electrical Calculations." By W. H. N. James and D. L. Sands. London: Longmans, Green and Co. 3s. 6d. net.

"Elementary Electrical Engineering." By J. H. Alexander. London: Crosby Lockwood & Son. 3s. 6d. net.

"High-Tension Power Transmission." A Series of Papers and Discussions presented at the meetings of the Amer.I.E.E., under the auspices of the Committee on High-Tension Transmission. New York: McGraw Publishing Co. $3.

"Science Abstracts." Sections A and B, October 25th, No. 94. London: E. & F. H. Spon. 1s. 6d. net each section.

"Fowler's Mechanical Engineers' Pocket-book, 1906." Edited by Wm. H. Fowler. Manchester: The Scientific Publishing Co. 1s. 6d. net (leather, 2s. 6d. net).

LIGHTING AND POWER NOTES.

Barking.—During his term of office as electrical engineer, Mr. A. H. Seabrook, who has just been appointed to West Ham, reduced the works costs from 3·42d. to 1·5d. per unit, which is a record for stations of the same size in the London district. The average charges have also been reduced from 3·4d. to 2·8d. In his first year he reduced the net loss from £1,000 to £274, and a net profit has been made each year since then; the power charge has also been reduced to 1d. per unit, and 90 per cent. of the local power users have adopted electric driving. Thus Mr. Seabrook takes up his new duties with an exceedingly good record.

Beckenham.—The U.D.C. decided on the 30th ult. that the necessary works for providing energy for the Penge tramways be proceeded with forthwith, at an estimated cost of £13,000. The order for machinery are, however, suspended until the draft agreement relating to the supply has been received from the B.E.T. Co. A committee was appointed to meet the company and discuss the price to be paid to the Council for energy.

Bettws-y-Coed.—The invitation of a local syndicate to apply for a provisional order for the lighting of the district by electricity has been accepted; the syndicate will bear all legal and other expenses incurred, on condition that they be given the first refusal of the carrying out of the scheme. Under the agreement the company undertake to have the scheme carried out within 18 months, failing which, the order will revert to the Council free of expense.

Birstall.—A L.G.B. inquiry was held recently into an application by the U.D.C. for sanction to borrow £2,000 for electrical purposes. The Council proposes to take energy in bulk from the Yorkshire Electric Power Co. at a cost of 3d. per unit for the first 1½ hours and 9d. per unit after the maximum supply of 126 units per 24 hours has been taken.

Bishop Auckland.—Electric street lighting has been adopted at West Auckland, to supplant the existing gas lamps.

Bradford.—The report of the Electricity Committee upon the work of the department during the past year has been issued. From it we gather that 16 additional lighting feeders are being laid for the purpose of augmenting the capacity of the consumers' networks in various parts of the city. The Committee has given instructions for the augmentation of the supply to the tramways by the laying of four additional feeders on the present system of supply, and the erection of two sub-stations for an extra high tension system of transmission, the outcome being that the tramways distribution system will be divided into 19 instead of 8 sections as at present. It having been decided to supply the districts outside the present area of supply by means of extra high tension feeders, sub-stations are arranged for at Thornbury and Odsal Top, and transformer chambers in Wakefield Road and Horton. These will be supplied with three-phase current at 6,500 volts, derived from motor-generators at the works. It has also been decided to lay a number of extra high tension feeders for general supply purposes on this system, for both transmission and distribution to several of the outlying portions of the city.

Brighton.—Mr. Arthur Wright has certified that a sum of £60,221 is due to the British Westinghouse Co. for plant supplied at Southwick. The two completed turbines and the converters have run very satisfactorily, and he expects in less than a fortnight that the Southwick plant will be in a position to supply a very considerable portion of the electricity consumed in Brighton.

Cheshunt.—The U.D.C. has received from the North Metropolitan Electrical Power Distribution Co., Ltd., a request for its consent to the application for a new prov. order for E.L., cancelling the Council's present order, and constituting the company the undertakers under the order. The Council on October 25th decided to ask the company if it had any serious intention of carrying out the lighting of the district under the present agreement.

Continental Notes.—Italy.—Application has been made to the prefectoral authorities of Ancona for a concession to put down a plant to utilise the water-power of the River Sentino, at Genga, in the generation of electrical energy for lighting purposes, and for the operation of a system of electric tramways in the district.

Germany.—The Electricitäts Gesellschaft, of Berlin, has secured a contract for the establishment of an electricity works in the town of Eberswalde, at an estimated cost of £18,000.

The municipal authorities of Celle have decided on the establishment of an electricity works in the town.

Spain.—La Compania Minera Industrial de Mancilla (Logrono) has) placed a contract for an electric power plant of 200 h.p., in connection with its mines.

A large electric power station is rapidly approaching completion at Laguna de Ruidera, for Messrs. Sedano & Co. The plant, which is being put down by the Spanish Siemens-Schuckert Co., consists of two sets of 560-h.p. turbo-alternators. The turbines were built by Messrs. Escher Wyss & Co. The three-phase current generated will be transmitted at a pressure of 30,000 volts to a number of industrial centres in the district, including Solano, Membrilla and Alhambra.

Dartford.—The U.D.C. has decided to terminate the free wiring contract. It is the intention of the Council to do "small jobs" itself.

Exeter.—A discussion recently took place on electrical extensions; the engineer reported that through promptly laying distributors in new streets, 61 houses out of the 68 erected were being supplied, and as 500 houses were being erected, the prospects were exceptionally good. Other engineers please note.

Foot's Cray.—The B. of T. has informed the U.D.C. that it will be prepared to consider an application for a prov. order authorising the Council to transfer its E.L. order to a company, and to extend the time for carrying out the order.

Hanley.—With the object of popularising electric lighting, &c., the T.C. has decided to print on the back of the account forms and rate demand notes advertisements bringing the advantages of the use of electricity to the notice of the general public.

King's Norton.—The U.D.C. has been informed that the B. of T. will be prepared to consider a proposal to transfer the Council's E.L. order to a company, and the Council has decided to negotiate with Messrs. Callender's Cable and Construction Co., Belliss & Morcom and the Electric Construction Co., with regard to the formation of a local syndicate to lease the order for 21 or 25 years, the Council to have the option of taking over the undertaking at the expiration of 10 years without paying any premium or compensation, or at any other period upon terms to be agreed.

Liversedge.—The U.D.C. after discussing a proposal to apply for a loan of £1,500 for carrying out an E.L. scheme in connection with the Yorkshire Power Co., decided to refer the matter back to the Committee.

London.—L.C.C.—The question of loans to local authorities was raised at a meeting of the Council on Tuesday last, when the Finance Committee stated that the Fulham B.C. had applied for an advance of £25,000 on account of proposed expenditure for extending the E.L. plant and mains. It appeared that the B.C. had also had before it a scheme for greatly extending the undertaking, and the committee had, therefore, been in communication with it as to whether, having regard to recent events in Parliament, the present was an opportune time for the borough to largely increase its generating plant. In reply, the Committee had been informed that the projected extensions were divided into three parts, the £25,000 now applied for being required to commence the first part of the work, the total estimated cost of which was £67,328. The second and third portions of the extension scheme would not be proceeded with until it had been fully demonstrated that the first extension had realised expectations. In view of the uncertainty as to the method of generating energy in London in the future, the Finance Committee would have preferred that large extensions of generating plant should not be undertaken by the borough councils at the present time. The work which formed the subject of the application for £25,000 had, however, been commenced, and under the circumstances the Committee thought the loan should be granted, and recommended accordingly.

Sir Melville Beachcroft expressed the opinion that bulk supply would be available in the future at ½d. per unit, whereas the borough councils could not supply at less than 1d. per unit. It was therefore necessary for the Council to hesitate before sanctioning the expenditure, and he moved that the consideration of the recommendation should be postponed.

Dr. Napier seconded the amendment, which was carried by 31 votes to 18, and the matter was consequently adjourned.

The Finance Committee brought forward other recommendations in regard to loans, and these were sanctioned. They related to an advance of £9,792 to the Battersea B.C. for an extension of boilers, plant, &c., necessary to supply steam to a new turbo-generator; £6,000 to the Hampstead B.C. for E.L. purposes; £90,405 to the Marylebone B.C. for various works; and £10,000 to the Stepney B.C. for E.L. works.

L.C.C. Bulk Supply.—The Council resolved, on the recommendation of the Highways Committee, to give notice by public advertisement of its intention to consider at the meeting on November 14th, a proposal to promote legislation in the next session relative to the supply by the Council of electrical energy in London and certain surrounding districts, and to defray the cost of such promotion out of the county fund. In a further report the Committee gave details of its reasons for endeavouring to secure powers of this kind. The report, which will be considered at the second meeting in November, proceeds to state:—

"The authority to be sought should, we think, include power (1) to supply energy in bulk throughout the whole of the area in question; and (2) to supply energy to large individual consumers, as, for instance, railway, canal and tramways companies or authorities, where these undertakings extend over more than one area.

"We have not at present gone fully into the details of a definite scheme for the supply of electrical energy, but, from reports which we have had before us, and having regard to the favourable position in which the Council stands in many respects, we are of opinion that it will be quite practicable to put forward a satisfactory scheme, bearing in mind the importance of providing cheap electrical energy for general use in London, and at the same time securing continuity of the policy of public control which was tended to be ensured by the purchase clauses of the E.L. Acts of 1882 and 1888.

"The Council on October 24th, 1905, authorised us with the Parliamentary Committee to confer with representatives of the London local authorities upon the whole question of the supply of electrical energy in London. It is proposed to hold this conference on Monday, November 20th, 1905, and we will then place our proposals, in the event of the Council adopting them, very fully before the local authorities. In the meantime, however, we have thought it right, having regard to the short time available for the issue of the necessary Parliamentary notices as to the deposit of a Bill, &c., to place before the Council this outline of the policy which we recommend it to adopt. We have, as required by Standing Orders Nos. A. 27 and A. 161, informed the Finance and Parliamentary Committees of our intention to recommend the Council in this sense. It is, however, necessary for us to ask the Council to suspend the operation of Standing Order No. A. 161, which requires that all proposals relating to applications to Parliament for powers shall be submitted to the Council not later than its first meeting in June of each year. We think that this is clearly a case of urgency, which comes within the class contemplated by Standing Order No. A. 162, inasmuch as it was not until August that it was known that the Administrative Co.'s Bill would not pass. We have consulted the solicitor, in accordance with Standing Order No. A. 163, and he is of opinion that the Council has power to promote legislation in the direction indicated, provided that the provisions of the Borough Funds Act, 1872, as applied by the County Councils (Bills in Parliament) Act, 1903, are adopted." The Committee, in conclusion, submit recommendations in order to give effect to these proposals. The views of the Finance Committee on the subject will be presented at a future meeting of the Council.

St. Pancras.—An L.C.C. loan of £1,874 for electric lighting purposes is to be taken up.

Fulham.—The Finance Committee has, in reply to its application to the L.C.C. to sanction a loan of £67,328 for E.L. extensions, received a communication from the Comptroller asking to be informed whether the B.C. had considered what would be the effect upon its electricity undertaking of the passing of any Bill for the supply of electricity in bulk in its area, such as the Administrative County of London and District Electric Power Co.'s Bill of last session. The borough treasurer has answered this communication, intimating that his Council has committed itself to carry out various necessary schemes of extension to the full amount of the loan applied for; and, in fact, had already spent about £25,000 in connection therewith, therefore the passage into law of any electricity Bill, such as referred to, could not be considered in the direction indicated in respect of the present application.

Islington.—The Lighting Committee of the B.C. has decided in favour of supporting action being taken by the L.C.C. or any Metropolitan B.C. to enable municipalities to give a bulk supply of electricity.

Leek.—The following revision of prices for energy to consumers has been approved by the U.D.C. Power rates to consumers whose installations do not exceed 20-B.H.P.: First 1,000 units consumed per quarter, 2d. per unit; second 1,000, 1½d.; all in excess of 2,000, 1½d.; installations exceeding 20-B.H.P. special terms. Flat rate charges, as an alternative to the maximum demand system: Offices, warehouses, and mills, 6d. per unit; shops, 5½d.; combined shops and private houses, 5d.; private houses, 4½d.; public houses, hotels, and clubs, 4d.

Macclesfield.—The electric lighting of the new Infirmary annexe at the Macclesfield County Asylum has now been completed, consisting of three steam dynamos, switchboard, wiring, &c. We understand that the whole of this installation has been carried out according to specifications at a saving of about 2 per cent. on the accepted tenders. The contractors for the wiring, fittings, and public lighting are Messrs. D. Firth & Son, of Manchester; and for the plant, Messrs. J. H. Holmes & Co. The consulting engineers are Messrs. Lacey, Sillar & Leigh, of Westminster, who have worked in conjunction with the county architect of Chester, Mr. H. Beswick.

Manchester.—Mr. Ross Hooper has, of late, had occasion to criticise the method of finance adopted by some municipalities, when he has made inquiry, on behalf of the L.G.B., into applications for loans for municipal electrical works. At the Town Hall on Friday last, an inquiry was held with reference to an application of the Electricity Committee for power to borrow a sum of £60,000 for additional equipment at the distributing and balancing stations, the provision of motors in connection with the motor hiring scheme, the erection of cottage property adjoining the Stuart Street works, and other matters. It was explained by the Chairman of the Electricity Committee that the purposes for which the present application was necessary were—additional plant £22,295, railway at the Stuart Street Station £17,850, distributing and balancing stations £14,285. These extensions were needed to enable the Corporation to deal with the increasing demand for energy. It was stated in the course of the inquiry that the greater part of the work had already been carried out and the money spent. This, Mr. Hooper observed, reduced the inquiry to a farce. He took exception to the action of the Committee in constructing the railway at Stuart Street station, for which a further sum of £17,850 was needed, without first obtaining the sanction of the L.G.B. It cost altogether over £32,000, and this was the first time any application had been made in respect of it. The city surveyor said the Department was assured before the work began that there would be a sufficient surplus to meet the cost out of the previous loan. The inspector said it was very unsatisfactory for him to have to inquire into the details of work which had been carried out three years before. No intimation had been given that the Board's sanction had been anticipated. The inspector said he could understand that the Department believed that it would have ample funds to complete the work; but, he added, when dealing with the item of £14,285 for excess expenditure on the distributing and balancing stations, there was a difficulty in following the accounts. The only way that the total of £14,000 odd had been arrived at was by adding up the total assets and the total liabilities, and then striking a balance. Then they found that they were £14,000 to the bad. Each sanction should have been kept separate. "I do not see," he continued, "how I can deal with that amount now, from the particulars before me. You have been running up an account on a floating capital, and now you have come to a settling day. You should have had a settling day before this." The inspector further pointed out that a 25 years' loan was being asked for in respect of expenditure which had been actually incurred 13 years ago, and that some of the items included in this application might not be allowed 25 years' repayment. The Town Clerk said, "The Corporation threw themselves on the indulgence of the L.G.B." The Inspector intimated that he was aware of the difficulties the department had had in one way and another, but they should have their settling days oftener. On

behalf of the Manchester Property Owners' Association, objection was made to the spending of money without the consent of the L.G.B. previously obtained. The present application, however, was not opposed, as its refusal would jeopardise the profits of the electricity undertaking, which it was hoped would be available for a reduction of rates in the near future.

The inquiry then closed.

Merthyr.—The local Traction and Lighting Co. has recently appealed against its assessment, which has since been reduced from £1,200 to £864 rateable value.

Newcastle-on-Tyne.—The Corporation is faced with the problem of providing more light in the city, and has to decide whether gas or electricity shall be used for that purpose. Mr. Ernest Hatton, the manager of the tramways which supplies all the energy used for Corporation purposes, has made a comparison of the costs in either case, so far at least as is possible; the hours of consumption are not identical. Assuming that the extensions are carried out by 180 additional arc lamps, each burning 2,793 hours per annum (including the reduction that will be made to the Committee in the existing arc lamps), he gets 380 arc lamps of 1,000 C.P. at £11 net per annum per lamp, costing in all £4,180; secondly, assuming that the extensions are carried out with 206 new type gas lamps, each burning 2,793 hours per annum, he gets 200 1,000-C.P. arc lamps, for which the Committee now pays £14 18s. 6d. per lamp per annum, in all £2,980; and the cost of 206 new type gas lamps at £3 5s. 6d. per annum each, £674 13s. in all, giving a total of £3,654 13s., or with discount £3,565 11s. 9d. This is £614 8s. 3d. less than by lighting the same length of streets by arc lamps; but it is to be noticed, he says, that the hours of burning for each gas lamp on this estimate have been reduced by 983 hours per lamp per annum. The average at present for gas lamps is 3,776 hours per annum, and if this were maintained, the c st of making the extension with gas lamps would be £3,711 10s. 1d., or £468 9s. 11d. less than for electricity.

Newcastle-under-Lyme.—The past year's working of the municipal electricity undertaking resulted in a gross profit of £160; a net deficit, however, is incurred of £262.

Newhaven.—The U.D.C. has come to the conclusion that it is not in a position to deal with the matter of E.L. for the town.

New Zealand.—WATER POWER.—A further report on this question has been submitted during the present session of Parliament by Mr. Allo. Surveys have been put in hand during the year to procure the necessary data for the design of works to utilise the power available at Huka Falls on the Waikato River, and in the Tauherimkau, Clarence, Opihi and Teviot Rivers; also further surveys will in a short time be started at the Hutt River, Lakes Rotoiti, Coleridge and Hauroko, these places appearing to be the most suitable in the first instance to give supplies of power to the present industrial centres of the colony.

The Huka Falls and Rotoiti-Kaituna schemes are alternative. The same remark holds good for the Hutt and Tauherimkau Rivers. In Canterbury it is to be decided whether a central scheme at Lake Coleridge, or two schemes, one at Hanmer, using the Clarence River, and another at Opihi, would be the more favourable. The two schemes combined would efficiently command the whole of Canterbury.

The survey of the Teviot River shows a scheme of about 25,000 H.P. to be practicable. Four schemes are available on this river, aggregating over 50,000 H.P.

Attention is being given to the developments in electric traction on railways.

The schemes proposed for immediate consideration, the amount of power expected to be derived from same, the probable total cost, and the amounts proposed to be voted for the current year, are as under:—

Scheme.	B.H.P.	Estimated cost.	Proposed vote.
Huka	38,000	£1,000,000	£10,000
Hutt	12,000	340,000	10,000
Clarence	25,000	600,000	10,000
Opihi	10,000	250,000	—
Teviot	25,000	600,000	10,000
Hauroko (partial development) ..	40,000	850,000	10,000
Totals	150,000	£3,640,000	£50,000

CHRISTCHURCH.—The City Council has resolved to call for tenders for the supply of additional plant for the destructor electrical works. A proposal that a loan of £11,450 be raised for the purpose has been referred to the Finance Committee.

DUNEDIN.—A report has been issued by the Finance Committee showing that £66,233 is required to complete the Waipori hydro-electric scheme, made up as follows:—

ESTIMATED COST TO COMPLETE, FROM JUNE 1ST.

Electrical plant	£45,138
Hydraulic works	5,452
Interest, say	5,000
City cables, say for three years	12,000
Converter station	10,723
Public lighting	10,560
Conduits, cradles, &c.	928
	£89,801
Deduct credit balance	23,568
Amount required	£66,233

The above provides for a single transmission line, and about £4,000 for contingencies in the tramway loan, and £8,365 in the Waipori loan. It is proposed to borrow £70,000 to complete the above works.

HAMILTON.—A small private E.L. installation was inaugurated in the town in September last by the Mayor. The plant, which has been installed by Messrs. Steuart & Fenn, comprises a Tangye 8-H.P. gas engine coupled to a 36-amp. 110-volt International generator. The lighting installation consists of 30 32-C.P. incandescent lamps and four 95-C.P. Nernst lamps.

Oldham.—With reference to an application of the Corporation for powers to borrow a further sum of £48,114 for the purpose of meeting expenses in connection with the electricity undertaking, Mr. H. Ross Hooper lately held an adjourned inquiry on behalf of the L.G.B. The electricity undertaking is alleged to have been largely over-capitalised. In respect of the Greenhill power station, the Corporation has borrowed under the Act of 1902, £156,501, and the further sum now asked for will bring the total expenditure up to £204,645. The application for further borrowing powers was made last December, and an inquiry was then opened by the Inspector, but he declined to proceed in the absence of comprehensive and full details, which the authorities undertook to supply. The electricity undertaking appears not to have been a financial success. In the course of the inquiry, the Inspector was appealed to, to put a stop to what was alleged to be extravagant expenditure. Replying to the Inspector, the borough accountant said the depreciation fund now stood at £9,459. He admitted that certain debts were being carried forward. The reserve in 1904 was £9,180; this year, therefore, there was an increase of £270. A credit balance, when there was one, was not necessarily transferred to the reserve. The Inspector expressed strong disapproval of the transference of three engines from Rhodes Bank to Greenhill; he further pointed out that the Corporation had lost money—this year, £1,300; and wished to know what were the prospects for next year.

The Greenhill station, it was further explained, was decided upon in 1901, when more power was found to be needed for working the tramways.

Mr. Hooper said that at the previous inquiry, the estimated demand for energy was found to be wrong. These works were now well nigh unproductive, an example of over-capitalisation. Greenhill station was built when, perhaps, Rhodes Bank might have been extended; and the Corporation had now about £75,000 of capital tied up. He considered the position a disastrous one, and wanted to know who was responsible. Mr. Alderman Bolton said the borough surveyor drew the plans and the Committee decided the number of cars. The estimates being based according to Mr. Alderman Bolton on their own ideas. The Inspector went on to say that the lack of a competent engineer explained all the loss. The Committee acted on their own responsibility in providing energy for 150 cars. An error of judgement had landed the Committee in a loss of £100,000 for plant that was unremunerative. More than half of it was lying idle, and when it came to be wanted—if ever—it might be out of date. Such expenditure ought never to have been incurred without expert advice. The proceedings then closed.

Ossett.—The T.C. has agreed to adopt a small E.L. scheme at a cost of £3,500, with a view to the retention of the prov. order, which was recently extended for two months by the B. of T.

Pontardawe.—The Council has decided to approach the Brynamenan Supply Co. for terms upon which it will provide public lighting for Caegurwen by electricity.

Rawtenstall.—The T.C. has received from the L.G.B. anction to borrow £12,)00 for the establishment of electricity works.

Shanghai.—A special meeting of the ratepayers was held at the Town Hall on June 5th last, to consider the electric light and tramways question. The Council has since October, 1899, received four separate batches of tenders for putting down a tramways scheme in the town, but negotiations were not entered into, to carry out a project until the tender of Messrs. Bruce Peebles was received, in March of this year. The Council did not offer a concession to take over its electricity undertaking, but the terms of the tramway concession insisted upon the company taking a supply of energy from the municipality. Upon the Council's decision to accept Messrs. Bruce Peebles tender to put down and work an electric tramway system in the district, the ratepayers called the above meeting to put forward a proposal to dispose of the electric light works in conjunction with the tramways concession. This proposal, however, was defeated. Provided the tramways scheme comes to pass, the Council will require to expend a sum of 100,000 to 120,000 taels on extensions to plant. During the discussion on the above, it was stated that borrowing money in the Far East was an expensive luxury, for when the Council obtained loans it must pay something like 6½ or 7 per cent. interest. For every 1,000 taels borrowed for 20 years, the Council has to repay the principal plus 632 taels in interest, but against these heavy financial charges, it is gratifying to note that the Shanghai municipality's average charge per unit, works out at 14 candareens against an average for the United Kingdom of 15½ candareens, and for public lighting at 175 taels, against 174 taels in this country. The balance to the credit of the net revenue account of the department at June last was 53,000 taels, but this is invested in the working capital of the undertaking. It appears that the department has no sinking fund account, the reason put forth for this is that some of the older loans bear interest at 5 and 5½ per cent., and that it is not good finance to pay these off and borrow afresh at 6 per cent.

South Africa.—BLOEMFONTEIN.—In accordance with the wishes of the T.C., Mr. R. Hammond has made a report on the general electric lighting of the town. He estimates the cost of

extensions at about £60,000. A reduction in the price of energy is advocated by Mr. Hammond as soon as the new plant is in operation.

Torquay.—A L.G.B. inquiry was held on Tuesday last, into the application of the Corporation for consent to a loan of £9,500 for the purposes of electric light and power supply. The inspector remarked that the inquiry was more or less the outcome of the inquiry held in January last, when an application was made for a loan of £42,000. The matter had been re-considered, and the loan now required was for £9,500.

Tyldesley.—The U.D.C. has decided to apply to the B. of T. for consent to an agreement with the Lancashire Electric Power Co. for a supply of energy in bulk.

U.S.A.—Tennessee.—The Chattanooga and Tennessee River Power Co. has, by an arrangement with the U.S. Government, decided to put down a 56,000-H.P. electric generating plant near Chattanooga City. The entire work, including a dam and a lock to accommodate vessels of about 250 ft. in length, is expected to be completed in about 14 months. The mains will be largely placed underground, owing to the mountainous character of the district.

New York.—A new drawbridge, operated by electricity, has been completed over the Newtown Creek, Brooklyn. Each of the two moving parts of the bridge weighs 1,000 tons or more. There are now connected with the mains of the New York Edison Co. on Manhattan Island motors aggregating 100,275 H.P.

Walthamstow.—The electrical engineer has been instructed to obtain tenders for the following:—Automatic switches for the generating station, an extra panel for the traction board, alterations to the gas generators, rearranging the old lighting switchboard (estimated cost between £600 and £700), motors for hire-purchase, &c.

West Hartlepool.—On October 26th a L.G.B. inquiry was held relative to the Corporation's application for a loan of £5,000 for E.L. purposes, the extensions being needed to supply the Seaton Carew Ironworks with 300 or 400 H.P. annually. There was no opposition.

Windsor.—Messrs. Foote & Milne, Ltd., have informed the R.D.C. that with regard to their application for E.L. powers for Sunningdale, they are willing to undertake to supply energy at the maximum rate of 6d. per unit, but in cases they wish to retain a discretionary power to charge at a higher rate not exceeding 8d. per unit.

TRAMWAY AND RAILWAY NOTES.

Bexley.—The B. of T. has informed the U.D.C. that it has sanctioned loans as follows:—£1,520 for cars; £392 for enlargement of battery; £1,299 for repair shop, hot water fitting, machinery, &c.; and £743 for a paint shop and weir and settling pond.

Dewsbury.—The reconstruction of the tramways for electrical working between Dewsbury and Birkenshaw has so far advanced that it was found possible to re-open the first section between Dewsbury and Batley on Saturday last. The Dewsbury and Batley section is about 1¼ miles in length, and the total length of the line will be about 4 miles. It was expected that the section from Birstall to Birkenshaw would be ready for opening towards the end of this week, but it will take about a month to complete the whole line. The line is owned by the Yorkshire (Woollen District) Tramway Co., a subsidiary company of the B.E.T. Co., and it will be worked in connection with the Spen Valley lines. At Birkenshaw the line will meet that of the Bradford City Corporation, and arrangements have been made for the issuing of through fares from Dewsbury to Bradford.

Edinburgh. — The town clerk has drawn up an elaborate report on the existing cable tramways and the extensions under consideration.

Exeter.—It was stated last week that the Council had spent up to the present £67,489, including £7,852 for the purchase of the old horse undertaking. If it constructed the whole of the rest of the tramways, the cost would be £31,800—making a total of £91,437. The cars had in the past six months carried two million persons, and taken close on £19,000.

Folkestone.—The T.C. has followed the action of Sandgate U.D.C. in deciding to recommend to the four local authorities in the district the electric tramway scheme submitted by the National Electric Construction Co.

Hertfordshire.—The C.C. has decided to apply for an order authorising the construction of a light railway from Bushey through Watford to Callow Land.

Ipswich.—The revenue of the Corporation tramways for the six months ending September 30th was £12,755, against working expenses of £8,437. Interest and sinking fund reduced the surplus for the six months to £1,540. The average receipts per car-mile during the past six months stand at 8·86d., against 8·92d. for the same period last year; and the average passengers per car-mile, similarly compared, were 8·99d. against 8·92d.

Jarrow-on-Tyne.—At a special meeting of the T.C. last week the Tramways Committee reported the receipt of a letter from the B.E.T. Co., asking the consent of the Council to allow the Albert Road section of the scheme to drop. This portion, it was stated, was of little importance, and was only included in the provisional order with a view to possible extensions. That was found to be impracticable, as the crossing of the railway line at the termination of the section was a thing that neither Parliament nor the B. of T. would consent to. The consent of the Council was all that was required before proceeding with the remainder of the work, as the company had already provisionally accepted a tender for the construction of the permanent way. The Committee recommended that the company be asked to carry out the scheme of the Light Railway Act, and that no further delay be consented to, and this was approved.

Kingston.—The T.C. has passed plans for the construction by the London United Tramways, Ltd., of a line from King's Road to the borough boundary in Richmond Road.

London.—L.C.C.—The L.C.C. recently resolved to seek confirmation in the next session of Parliament of an agreement entered into for the acquisition of certain short lengths of tramways in or on the boundary of the county, and connected with the northern tramways. It was decided to postpone for a week the consideration of a proposal to expend £803,600 for the purpose of converting certain of the northern tramways to the underground conduit system. The lines concerned, which have a total length of 22½ miles, are as follows:—(1) Theobald's Road terminus, *viâ* Clerkenwell Road, Old Street, Great Eastern Street, Commercial Street and Leman Street to near the London Docks; (2) Norton Folgate terminus, *viâ* Shoreditch, Kingsland Road, High Street and Stoke Newington Road to Stamford Hill; (3) Aldgate terminus, *viâ* Commercial Road, Commercial Road East, and East India Dock Road to Poplar; (4) Moorgate Street terminus, *viâ* Finsbury Pavement and City Road to junction with Old Street; (5) Holborn terminus, *viâ* Gray's Inn Road to junction with Theobald's Road; and (6) along Old Street, between Great Eastern Street and Shoreditch; and it is hoped to complete the reconstruction of this section of the tramways by Christmas, 1906. By dealing with this portion of the lines first, it will be practicable to run electric car services on complete routes with a minimum of interference with the services on other lines.

Metropolitan District Railway.—The electrification of the District Railway is nearly complete, only four or five steam trains being in use. A further improvement will be initiated by the end of the month in the shape of the establishment of zone fares. The public will be able to ride from any City station westward of Aldgate to Hammersmith for a twopenny fare, and for longer distances there will be threepenny, fourpenny, and fivepenny tickets. Twopenny tickets will also be issued from Aldgate to High Street, Kensington, on the Inner Circle. Beyond Hammersmith, on the lines worked by the District Railway, an additional twopence will take a passenger any distance on the system. It is hoped eventually to run 40 trains an hour, or a 1½ minute service, but at the outset, after the pneumatic signalling is in operation, the service will be a two-minute one between the City and Gloucester Road or Earl's Court.

Metropolitan Railway.—The Metropolitan Railway Co. announces an important reduction of fares between the West End and Paddington and the City as far as Aldgate. The reduced fares enable the public to travel from Paddington to the City, either to Moorgate Street, Bishopsgate, or Aldgate, for 2d. third-class, and 3d. first-class. The first-class fare was previously 6d. There is no doubt, the company states, that 2d. will become the recognised fare. The 1d. and 1½d. fares for shorter distance are retained.

Tramways over the Bridges.—The Bridge House Estates Committee is to present a report to the Court of Common Council recommending that, in order to provide for the passage of tramways over Blackfriars Bridge, that structure should be widened to the extent of 40 ft. No cars will be allowed to stop while passing over the bridge or within a certain distance of it.

St. Pancras.—The General Purposes Committee of the B.C. has passed a resolution affirming the desirability of electrifying the L.C.C. tramway from Holborn, along Gray's Inn Road to Hampstead.

Marylebone.—The B.C. has agreed to consent to the construction of the proposed tramway in the Edgware Road to the Marble Arch. Letters were read from the L.C.C. intimating that the underground conduit system would be adopted, and that the B.C. would not be called upon to contribute towards the cost of street widenings.

Manchester.—The Trafford Park Estates Co. have agreed to withdraw a claim which they recently made against the Manchester and Salford Corporations, in respect of the Park tramways, on an undertaking being given that a tramcar service shall begin at once. The crossing of the Trafford Road swing bridge—a difficult undertaking—was successfully solved, and the first trams crossed the Ship Canal by that bridge on Monday last week.

Middlesex.—At a recent meeting of the County Council, the Light Railways Committee reported that Clause 5 of the agreement with the Metropolitan Electric Tramways, Ltd., provided that the energy used by the company for the purposes of the lines was to be measured separately from all other energy, by meters placed in such positions as might be agreed upon, within or close to the sub-stations. The company now asked the County Council to consent to the energy used being apportioned to the various sections on the basis of the car-mileage run. Clause 5 was open to objection on the ground of its impracticability on a system such as

the Metropolitan Electric Tramways, where there was a variety of ownership. The Great North Road would, for instance, in the near future consist of three separate sections worked as one route. The provision of special meters at the points where one section joins another and the special arrangements which would have to be made to sectionalise the cable system so as to comply with the clause would not only prove costly in the first instance, but would be a source of trouble at all times. The Committee recommended the granting of the company's application, as the Council would be a distinct gainer under the new arrangement, and the recommendation was adopted. Motions were adopted (1) for a Bill to be introduced next session authorising a line from Edgware Road, Cricklewood to High Road, Kilburn; (2) for application to be made to the Light Railway Commissioners for authority to construct a line from Edgware through Stanmore to the county boundary; (3) for steps to be taken to make a similar application with regard to a proposed line from Wembley through Wealdstone to Edgware.

Newcastle-on-Tyne.—At the meeting of the Tramways Committee of the Corporation on the 26th ult., it was reported that Col. Von Donop had visited the Fisher Hill section of the tramways, and stated that he considered it was of so dangerous a character that the B. of T. would not allow it to be worked. A number of experiments had been made by the Committee to see if the traffic could be conducted safely. Four cars had been fitted with special brakes, and several times attempts had been made to work the gradient and the curve. On every occasion the cars had got away in spite of the brakes, and on the return journey each failed to take the gradient. So the matter rests for the present, but the subject will have to be debated by the Council, when some interesting facts may come to light as to how the ratepayers' money has been spent. The Fisher Hill section lies between Wallsend and Walker, but within the city boundary, and is an incline with a very broken gradient, parts of it being as steep as 1 in 8. The section is included in the running powers that some time ago were given to the Tyneside Tramways and Tramroads Co., and the latter company has been desirous of getting the route open. A vast amount of money has been spent, for when the Corporation commenced the work of laying the permanent way it was found that the railway bridge at the foot of the hill would have to be altered. Another iron span was made for the railway, and a new road cut through the embankment. This done, it was found that the curve was still awkward, and a public-house had to be bought at the corner. Despite what was done, the cars were unable to negotiate the hill, there being much apprehension as to their slipping as they were ascending. What will be done it is difficult to say, but a suggestion has been thrown out that the difficulty might be overcome by resorting to a more circuitous course. At the same meeting of the Committee it was reported that a request had been received from the Newburn U.D.C. asking that the system should be extended to that place, which lies to the west of the city.

New Zealand.—Wellington.—Six new cars for the City Council recently arrived from England by the steamships *Ionic* and *Waimate*. A deputation from the Trades and Labour Council and the Industrial Association waited upon the Council, and requested that in future all car-bodies should be made locally. The Tramways Committee stated in reply that it had recommended the Council to have all new cars manufactured in Wellington.

The City Council has adopted the recommendation of the Tramways and Finance Committee to ask the ratepayers to sanction a loan of £22,000 for the completion of the Melrose tramways and extensions at Roseneath and Kilbirnie.

Dunedin.—The Finance Committee recently reported that £12,865 was required to complete the construction of the tramways.

North-Eastern Railway.—The fusing of some wires at the Wallsend-on-Tyne transforming station of the North-Eastern Railway on the 28th ult. caused a fire, which led to a delay of about an hour in the traffic on the electric railway between Newcastle-on-Tyne and Tynemouth. The official report stated that the accident occurred in the following manner:—The contractors to the railway company for the erection of the sub-stations were making preparations for some final tests on the machinery which they had supplied, and in order to carry out these tests they erected some temporary cables. During the progress of preliminary tests the temporary cables fused and set fire to several other cables, which were used for feeding the railway. The actual damage done by the fire was insignificant, and none of the machinery was burnt in any way. The train service would not have been delayed even for an hour if it had not been that the telephone box was the chief thing that caught fire and could not be used. The sub-station was running again on Tuesday morning. A good deal of inconvenience was caused by the stoppage, as many of the trains were far from any station when they were brought to a standstill, and the hour—five o'clock in the evening—was a time when many of the people who had been shopping were returning home.

There seems to be every probability that the system of electric traction which has been adopted on the two lines between Newcastle and Tynemouth may be extended. There have been persistent rumours that this was to be done, and there are good grounds to believe that steps in this direction are even now being taken. The line said, on good authority, to be concerned in the last proposal is that between the City and South Shields, a distance of about 10 miles. Surveys of the line are being made, it is said, as a preliminary step, and after these have been completed it is expected that a start will be made with laying the third rail. A fact that at least lends some air of truth to this statement, is that by the middle of next year the famous bridge over the Tyne, which was designed by Robert Stephenson, will be relieved of a considerable amount of traffic by the opening of the new railway bridge now in course of construction to the westward, and this may leave the way clear to the suggested enterprise. There is practically a continuous town along the south side of the river, comprised in the urban districts of Gateshead, Felling, Pelaw, Hebburn, Jarrow and South Shields, and there is an immense industrial population there resident, as well as a large migrant population attracted by the great shipyards on the river banks.

It is reported that the directors also have under consideration the electrification of the railway between Newcastle and Sunderland.

United States.—Rochester (N.Y.).—The Buffalo and Rochester Traction Co., with a capital of £700,000, will build and operate a 60-mile electric railroad between Rochester and Depew.

Spokane (Wash.).—A number of Westinghouse single-phase A.C. motors have been ordered for the Spokane and Inland Railway, a new company which is planning to build an electric railway 146 miles in length from Spokane to Moscow (Wash.). Power will be obtained from the Washington Water Power Co., which has built a plant on the Spokane River, and will be, according to the report in the *New York Tribune*, transmitted from the power house to the railway at 4,000 volts. The railway company's transformers will raise this voltage to 50,000, and step it down for traction purposes at 15 sub-stations along the line. For passenger service each motor-car will be equipped with four 100-H.P. motors, capable of giving a speed of from 35 to 40 miles an hour. For light goods traffic 150-H.P. motors will be used, and for heavy goods trains double locomotives made up of two portions, each weighing 40 tons. The value of the electrical equipment already ordered is £200,000. It is claimed that this will be the longest electrical railway line in the United States.

New York.—On Friday last the city celebrated the first anniversary of the opening of the Rapid Transit subway, which during the year has carried 106 million passengers.

Wednesbury.—The T.C. on October 25th decided to acquire the remaining portion of the recently electrically-equipped tramways in the town belonging to the South Staffordshire Tramway Co. This is the last section to be taken over by the Council.

Wolverhampton.—The question of intercommunication between the borough and the outlying districts has been in abeyance for some time. One step forward, however, seems to have been made on Saturday last, when a skate was attached to a trolley car, and passengers were conveyed between Snow Hill and the Fighting Cocks, whence the B.E.T. Co.'s line runs to Sedgley outside the borough; everything worked smoothly and satisfactorily.

TELEGRAPH AND TELEPHONE NOTES.

Australia.—Mail advices received in London on Monday stated that a successful telegraphic test was made between Broome, West Australia, and Cape York, Northern Queensland, *viâ* Perth, Adelaide, Melbourne, Sydney, Brisbane, Bowen and Townsville. The total length of the circuit was 6,500 miles, which is said to be almost a record. The chief electrical engineer (Mr. Howard) of the postal department in a report says the experiment commenced at 11 a.m., but owing to one or two slight delays, Broome was not connected with Cape York till about noon, when the connection was established. Conversations were carried on easily and plainly at the rate of 15 to 20 words per minute. The fact that direct communication passed successfully between the two places is regarded by Mr. Howard as very remarkable. The trial showed to the satisfaction of all concerned, he says, that speaking from one end of Australia to the other through automatic repeaters is practicable.

About 2,500 tons of copper wire will be required for the construction of the telephone line between Melbourne and Sydney, and tenders for its supply are shortly to be invited by the postal authorities. The wire is to be of a size weighing 600 lb. to one mile.

The Commonwealth Postal Department has ordered 12 Yetman transmitters, two for use in each State.

Special consideration is being given by the Postmaster-General and the secretary of his department to a suggestion for a period of free competition amongst rival wireless telegraph systems, before any one system is officially adopted by the Commonwealth. It is understood that the Postmaster-General is favourable to a system of licences so long as no vested interests are created by their issue in any case before the Commonwealth has officially adopted any patented system. Tenders will be invited to supply the Postal Department with the plant, which will in every sense become the property of the Government. It is, however, a question whether at present any system of wireless telegraphy should be permitted a monopoly of the coasts of the Commonwealth.

Russia.—During the Russian riots telegraphic communication was destroyed. The office at St. Petersburg was strongly guarded, as an attempt to blow it up was feared. The French Post Office stopped issuing telegraphic money orders. The telephone system was in the hands of sappers, who worked the exchanges.

Shanghai.—The North German Cable Works at Nordenham on the 26th ult. received a telegram announcing the laying of the cable between Shanghai and Yap. Final tests showed the electric condition of the cable to be perfect, and it was opened on the 1st inst. for traffic.

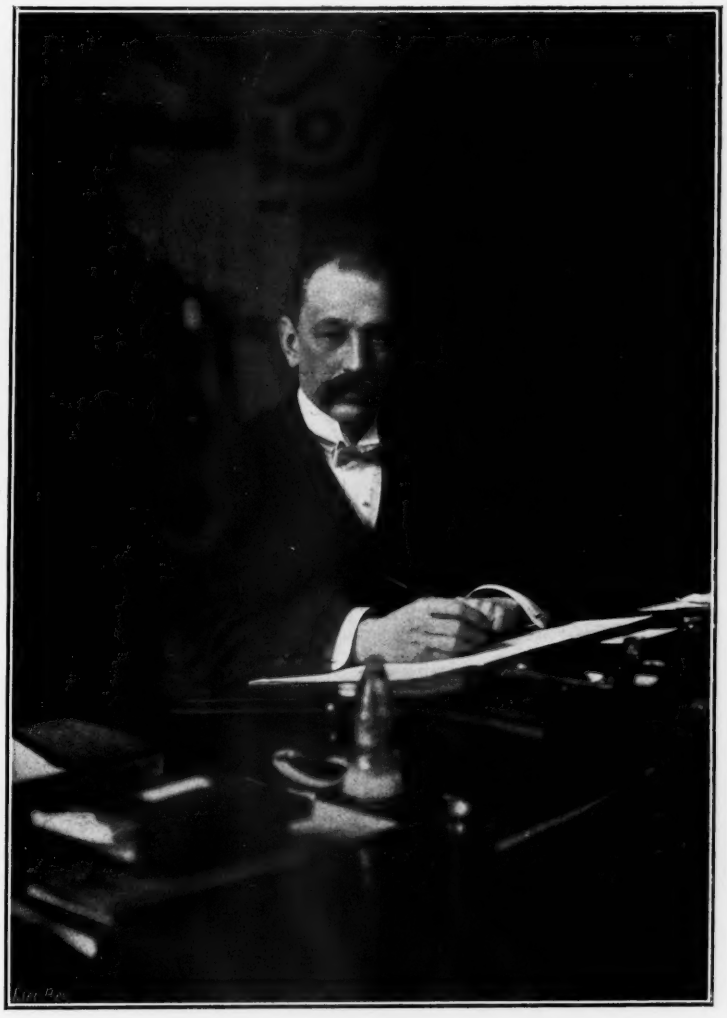
(*Continued on page 736.*)

JOHN GAVEY.

PRESIDENT OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

Mr. John Gavey, C.B., M.Inst.C.E., engineer-in-chief and electrician of the Post Office, and president of the Institution of Electrical Engineers, whose portrait we give, was born in Jersey (Channel Islands) on August 11th, 1842, and is therefore 63 years of age. He was educated at Victoria College, Jersey. In 1860 he joined the Electric and International Telegraph Co., and in their service acquired an extensive knowledge of telegraph engineering. In 1870, on the transfer of the telegraphic systems of the United Kingdom to the State, he was appointed superintendent of the South-Eastern Division, and in 1872 was transferred to the Great Western Division, with headquarters at Bristol, under Mr. (now Sir William) Preece, divisional engineer of the Southern District. During his term of service at Bristol, Mr. Gavey was engaged, amongst other work, in the construction of heavy trunk lines forming some of the most important telegraphic links in the country. In 1878, on the greater portion of the Southern District being taken over by the Royal Engineers, Mr. Gavey became superintending engineer of the South Wales District, with headquarters at Cardiff. His service there was of a varied and important character, embracing every class of telegraphic and, later, of telephonic work. The improvements in fast-speed Wheatstone working, which eventually resulted in a rate of 250 words per minute and more being attained, were largely due to Mr. Gavey's investigations. The conditions for high-speed working through underground cables in connection with land lines were also gone into carefully by him with most satisfactory results. Whilst engineer in South Wales, Mr. Gavey turned his attention to wireless telegraphy by induction, and made numerous and important experiments in connection with this branch of the subject. Under his directions, telegraphic communication was established between Lavernock on the mainland, and the Flat Holmes island in the Bristol Channel. The spread of the telephone system gave Mr. Gavey full scope for his energy, and under his direction the first postal telephone line connecting two large towns was established between Cardiff and Newport in 1881.

In 1892, on the death of Mr. E. Graves (then engineer-in-chief), Mr. Gavey was appointed to the position of principal technical officer, at headquarters, and in this position he carried out further important experiments in wireless telegraphy by induction, and succeeded in establishing telephonic communication by its means across Loch Ness, a distance of 4 miles, the experiments eventually resulting in the permanent installation of communication by telephone with the lighthouse on the Skerries, near Liverpool.



Photograph by] [Elliott & Fry.

John Gavey, C.B., M.Inst.C.E.,
President of the Institution of Electrical Engineers.

Although Mr. Gavey has very largely and successfully dealt with such matters as telephone switching apparatus, long-distance telephonic transmission, &c., perhaps the largest and most important work he has been engaged on in connection with telephonic intercommunication has been the installation of the immense network of underground wires which now ramify the streets of London and stretch out to the suburbs in every direction. Another important work entrusted to Mr. Gavey was the valuation of the National Telephone Co.'s trunk lines when the latter were in process of acquisition by the Post Office. Subsequently he undertook the organisation and development of the trunk telephone system throughout the country.

Mr. Gavey served as juror to the electrical section of the Paris Exhibition of 1900, and was a delegate to the International Electrical Congress in the same year. In 1903 he was appointed an official delegate at the preliminary International Congress on Wireless Telegraphy, held at Berlin. He was a member of the British Committee of the St. Louis Exhibition in America, in 1904. He is chairman of the Telegraph and Telephone Sub-Committee of the Engineering

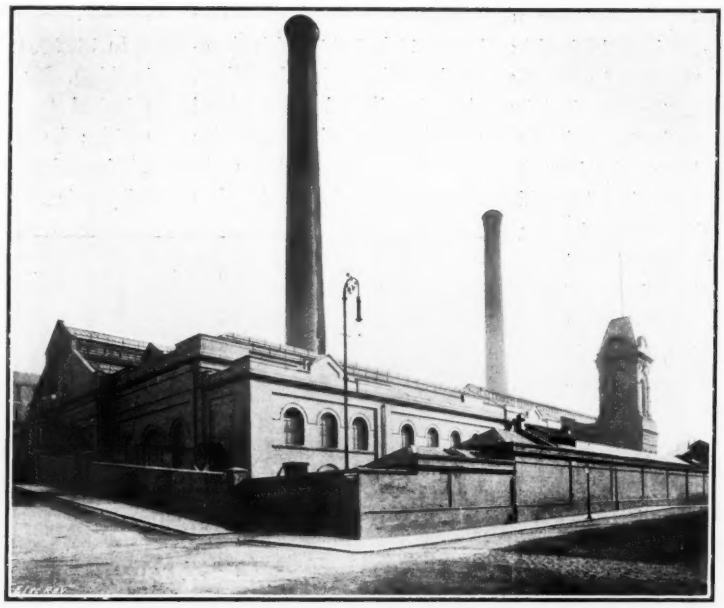
Standards Committee, and under his chairmanship some valuable reports on telegraph material have been issued; he is also a member of the Electrical Plant Committee.

As a member of the Institution of Electrical Engineers, Mr. Gavey has contributed several valuable papers on various telegraphic and telephonic subjects. He was also in the early days a frequent contributor to the ELECTRICAL REVIEW, then known as the *Telegraphic Journal*.

An appreciation of the eminent services which Mr. Gavey has rendered to the State and to the public was recognised by the distinction of C.B. which was conferred on him in 1903. His straightforwardness has gained for him the esteem and affection of all who admire a frank, fearless and manly nature; and he is as modest as he is able.

NEW TURBINE PLANT AT PORT DUNDAS GENERATING STATION, GLASGOW.

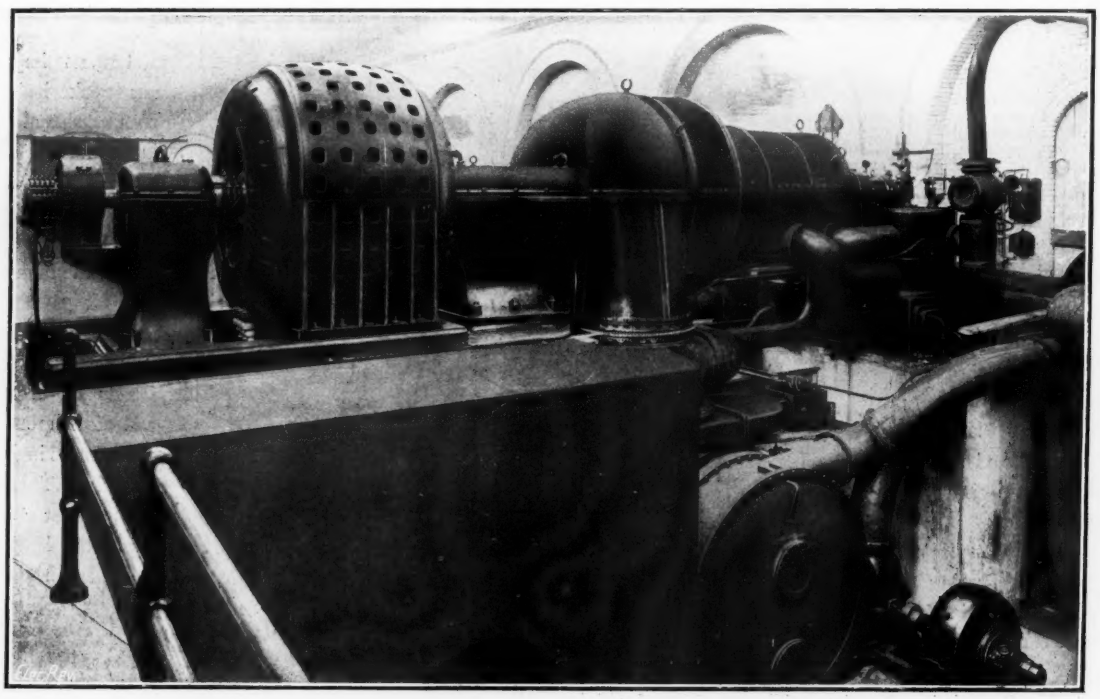
THE Glasgow Corporation has earned for itself a reputation for progress in all matters connected with its electrical undertakings, and if its policy as regards the electric lighting department's generating stations has resulted in an accumulation of plant of somewhat diverse patterns, we believe that few will quarrel with its recent turbine extensions at the Port Dundas and St. Andrew's Cross stations. When, two years ago, new generating machinery was found necessary, Mr. W. A. Chamen, the then chief engineer, advised the extension of the Port Dundas station, and the designing of the new portion for the installation of six 3,000-KW. turbo-alternators. Two of these sets were ordered, while a 1,500-KW. direct-current set was erected in St. Andrew's Cross station (see ELECTRICAL REVIEW, September 22nd, 1905, p. 464) in the southern district of the city.



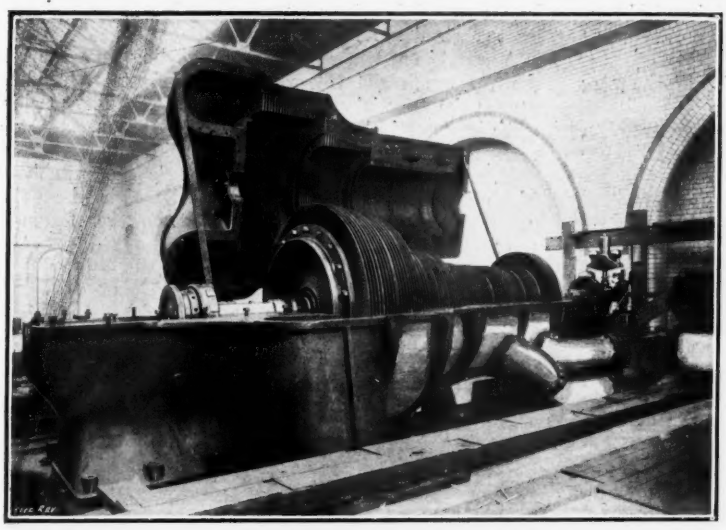
PORT DUNDAS GENERATING STATION, GLASGOW.

In carrying out the extension at Port Dundas, great difficulty was encountered in placing the boilers within the available space, and at the same time keeping to the original scheme of bunkers, &c. The new boilers are the largest size turned out by Messrs. Babcock & Wilcox, the heating surface of each being 6,182 sq. ft., with a grate area of 100 sq. ft., and the working pressure 200 lb. per sq. in. Superheaters and chain-grate stokers have been fitted, together with automatic weighing machines for weighing the coal, while Green economisers and induced-draught fans add to the completeness of the installation.

The turbines are direct-coupled to three-phase alternators of 3,000 KW. normal capacity each, which are capable of carrying an overload of 25 per cent. for two hours and 50 per cent. for half an hour. The turbines were supplied by Messrs. Willans & Robinson, and are of the Parsons type, with the improvements which this firm has adopted. The speed is 750 r.p.m. The blading throughout is built up in complete half rings before being placed in the turbine, and the blade rings are protected at their



3,000-KW. WILLANS-DICK, KERR TURBO-ALTERNATOR, PORT DUNDAS.



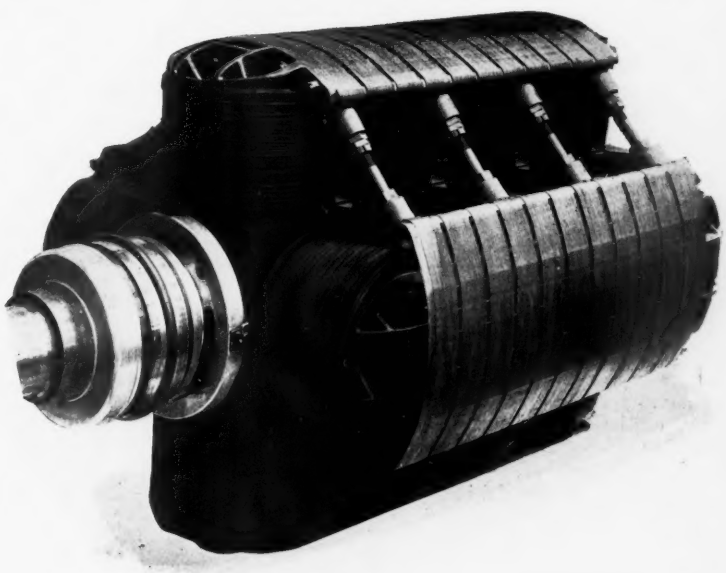
Wielans Turbine, showing Upper Half Turned Back for Inspection.

outer ends by a channel shrouding strip, which gives the blading a particularly strong and rigid appearance. The governor gear, oil pump, &c., have been placed on the lower half of the casing, and arranged so that the bearing caps can be lifted and the upper half of the casing turned back for the inspection of the interior of the turbine or working portions of the bearing and thrust gear. The exhaust end of the turbine has been arranged so that the exhaust to the condenser is taken down through two pipes, which allows the exhaust end bearing to be rigidly supported close up to the main portion of the turbine spindle, thus reducing the length between the turbine end bearings. With regard to the foundations, these consist of two concrete piers, one supporting the generator bedplate and the other supporting the oil tank, on which rests the steam end of the turbine, the turbo-generators being arranged on the level of the switchboard gallery, with the condensing plant on the normal engine-room floor level. The valves of the throttle and by-pass are arranged in a separate box bolted to the steam end bearing of the turbine, and the governors are driven through the gearing by a small extension shaft; the governor gear and the adjustment of the thrust are designed so that there is perfect accessibility at all times without the possibility of derangement due to careless handling. Compared with the reciprocating plant installed in the station, the turbine units run remarkably well in balance and provide a forcible illustration of the amount of power which can be got into small compass.

The surface condensing plant is installed immediately under the turbines, and has been manufactured by Messrs. W. H. Allen & Son. It has been designed to give a vacuum of $2\frac{1}{2}$ in. below the reading of the barometer when the turbine is giving its full output of 3,000 kw.

The air pumps are of the three-throw Edwards type, and, together with the circulating pumps, are motor-driven.

Messrs. Dick, Kerr & Co. supplied the



Dick, Kerr Rotating Field for 3,000-kw. Turbo-Alternator

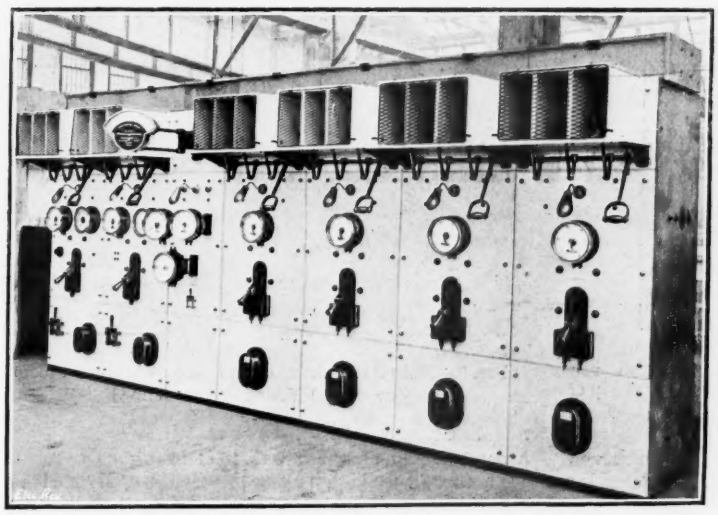


Fig. 1.—Three-phase 3,000-volt Main Switchboard—Front View.

Fig. 2.—Back View.

Colliery and Mining Switchgear (See p. 725).

generators, which are of the three-phase revolving-field type with 6,500 volts pressure between terminals, the frequency being 25.

The exciters are mounted on an extension of the rotor shafts, the exciting pressure being 50-60 volts.

The stator frame follows the makers' standard construction,

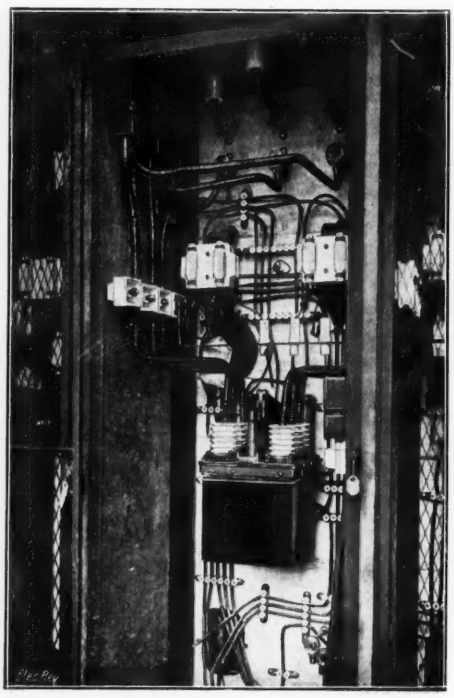


Fig. 3.—Three-phase 3,000-volt Main Switchboard for Colliery Work. (Portion of back with "expanded metal" guard of one panel removed.)

with former-wound coils embedded in rectangular slots: the stator can be moved laterally to admit of inspection of the revolving element. At present the neutral point of the winding is not earthed.

The rotor is of special interest, as owing to the high peripheral speed, its electrical design has necessarily been

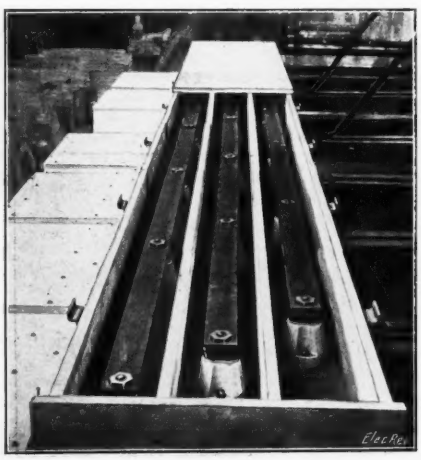


Fig. 4.—Three-phase 3,000-volt Main Switchboard for Colliery Work. (View showing encased bus-bars at top of board.)

subordinated to mechanical considerations. It consists of three solid pressed steel castings, the central one carrying four laminated pole tips.

The field coils are of stout edge-wound copper, the turns being insulated with paper and mica, and the outside edges left bare. Wedge pieces between the poles, stayed with bolts, secure their absolute rigidity.

A complete system of air ducts extending from the rotor shaft, through the pole-pieces, tips and stator windings, secures the essential coolness when running. The machines make comparatively little noise in operation, and their performance on test will be looked for with interest.

Messrs. Witting, Eborall & Co. made the switchboard which is arranged to control eventually eight three-phase generators and 20 feeders. At present, however, the instal-

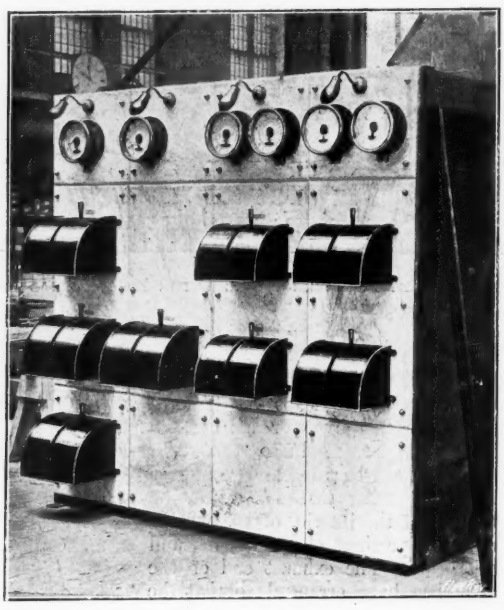


Fig. 5.—Main Switchboard for Use on Colliery Circuits up to 650 Volts.

lation consists of apparatus to deal with two double-current generators, which have been used as D.C. machines for the last five years, and nine feeders. There are two sections in the switchgear, which is of the remote control type, consisting of the operating panels and the high pressure

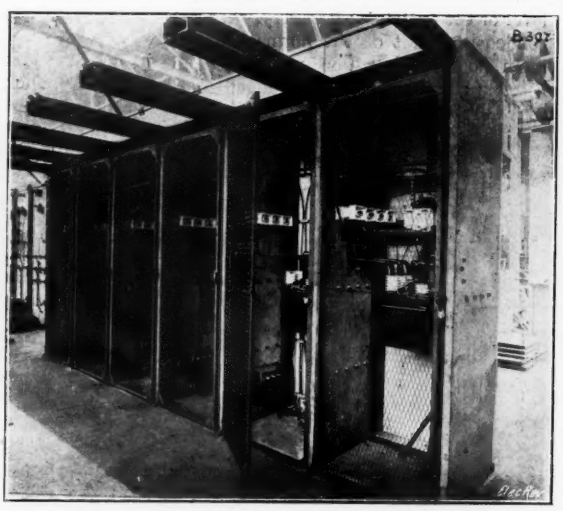


Fig. 6.—Main Switchboard for Use on Colliery Circuits up to 650 Volts. (Back View.)

apparatus. The former are situated in the engine room, and from there the high pressure switchgear, situated in an adjacent room, is electrically controlled. The high-pressure gear is sub-divided in brickwork compartments sealed by means of iron doors.

The bus-bars are in duplicate, inter-connecting switches at the ends being provided. In order that any generator or feeder may be switched on to either bus-bar, selector switches are fitted. The small wiring is all run in screwed iron piping except at the back of the operating panels. The generator and feeder switches are arranged with each phase in a separate oil tank and with four breaks per phase. The feeder switches, although normally carrying only 100 amperes as a maximum, are capable of breaking safely the total horse-power of the station. The instruments are worked from current and pressure transformers fixed in the high-tension compartments. The relays on the feeder panels are of the three-phase overload time-limit type, those on the generator panels being of the reverse-current type without time-limit attachment. The adjustment is such that the switches would open should a reverse current equal to 50 per cent. of the normal full load current get into the generator circuit. The relays may be cut out of action while the machines are being synchronised. It is claimed for the general arrangement of the gear (1) that accidental contact with any of the high pressure gear, whether exposed or not, is absolutely impossible; (2) should any single piece of apparatus fail or fire, the damage will be confined to the particular compartment in which the accident takes place; (3) any panel or portion of the bus-bars may be completely isolated by means of the section switches for inspection, cleaning, or repair, without interrupting the supply in any way; (4) apparatus requiring occasional inspection, such as excess pressure dischargers, are placed in a readily accessible position, and proper provision is made for getting out the oil switches for overhauling or renewing the oil; and (5) the only fuses used are in the primaries of the pressure transformers; the earthing of the framework, the cases of all transformers and switches and the secondaries of the transformers and any part of the bus-bars or high pressure apparatus which the staff may require to handle, has been carefully carried out. The inter-connecting cables are rubber-covered and served with an incombustible double braiding and compound. Where the connections pass through partitions or require support they are mounted on porcelain insulators and tubes. The cables from the power station switchboard are three-core, and run to various sub-stations in the city; in these 1,000 and 500-KW. motor-generators of the British Westinghouse Co.'s make are installed. The motors are of the induction type, taking current at a pressure of 6,500 volts direct on the stator windings; the D.C. side delivers current at 250 or 500 volts pressure for distribution to consumers. The motor-generators are all arranged for starting up from the D.C. side, but at least one set in each sub-station can be started up from the A.C. side as well, in case the D.C. supply fails from any cause. For balancing purposes some of the 500-volt D.C. windings are tapped, the tappings being led to slip rings connected to choking coils. The starting switches in the sub-stations are all of the water type, and the results obtained from them have been very satisfactory. The high tension switchgear, supplied by the British Westinghouse Co., is on the same lines as that in the power station. The D.C. generator switchgear includes automatic reverse current circuit-breakers on each pole, without any fuses, the only fuses employed being on the low-tension feeders.

COLLIERY AND MINING SWITCHGEAR FOR HIGH AND LOW TENSION ALTERNATING-CURRENT SERVICE.

By A. M. RANDOLPH.

The use of electricity has, in a large measure, revolutionised the cost of production and been the saving factor of many commercial undertakings. In no industry, perhaps, has this effect been so marked as in the case of colliery and mining work, which offers an ideal field for the application of electricity to the economical performance of every operation hitherto carried out by steam or compressed air. This fact has rapidly come to be recognised by owners of collieries, and is regarded as fundamental to the success of one of the most important of our staple industries.

It is desired in the present article to call attention to the recent development by the British Westinghouse Electric and Manufacturing Co., Ltd., of a special line of switchgear and control apparatus for use in connection with mining operations. This development has been based on the exceptional experience of the Westinghouse Co. in the application of electricity to mining work, and is the result of careful consideration given to the details of the apparatus by its engineers, ensuring that special conditions of operation are met by suitability of design.

Attention has been paid to the rules and regulations issued by the Home Office for the use of electricity in mines, the requirements of which have been embodied in the designs herein described. A brief description of these designs will be given under the following headings:—

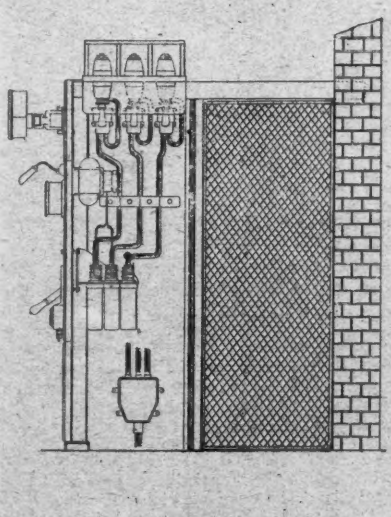


Fig. 7.—Three-phase 3,000-volt Main Switchboard. (Section.)

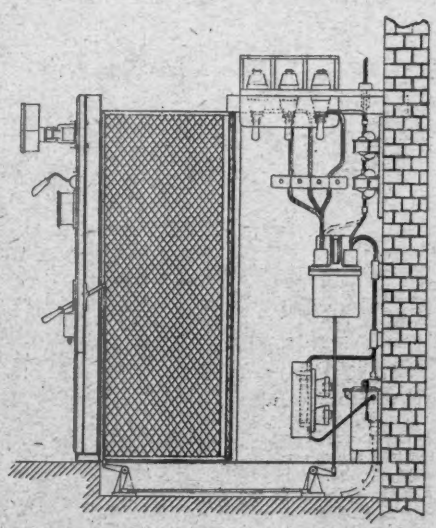


Fig. 8.—Distant Control. Three-phase Main Switchboard. (Section.)

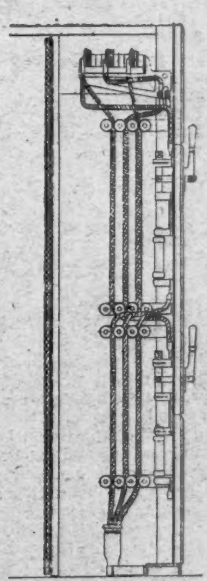


Fig. 9.—Non-isolated Type of Three-phase Switchboard for Circuits up to 650 Volts. (Side Elevation.)

1. Main and distributing switchboards.—Above ground.
2. Distribution boards.—Underground.
3. Motor-control gear.—Undergound and above ground.
4. Miscellaneous apparatus.

Main and Distribution Switchboards.—Above ground. High pressure up to 3,000 volts. Figs. 1, 2 and 3 (pp. 723 and 724) show respectively a front view, back view and details of wiring in one of the compartments of a main generating station switchboard recently built by the British Westinghouse Electric and Manufacturing Co. for 3,000-volt three-phase colliery service,* and fig. 4 shows the method of installing the bus-bars on this board.

* These figures were made from photographs taken before shipment.

Switchboards for power-house service are preferably made up of polished marble panels with a neat bevel on all front edges. The panels are carried on an angle iron framework designed to facilitate extensions, and the complete board is provided with efficient means for bracing from a rear wall.

The main bus-bars are supported (see fig. 4) on high grade porcelain insulators at the top and towards the rear of the board, each bar being separated from adjacent bars by slate partitions. Thus a sectional view of the bus-bar chambers presents a number of rectangular cells running the whole length of the board, each cell containing one bar, and the number of cells being governed by the number of phases of the system. In addition to these partitions, removable top slabs of slate are arranged so that the bus-bars are completely covered in. Reference to fig. 4 will show that the possibility of an arc occurring between the bars is entirely eliminated, and that while the bars are readily accessible for inspection and repairs, the danger of accidental contact with them is reduced to a minimum.

The connections (fig. 3) between the bus-bars and main switches are made with insulated and fire-proofed cable carefully arranged and supported on porcelain insulators where necessary. All instruments and automatic switch-tripping coils are actuated from the secondary windings of highly insulated current transformers mounted at the rear of the switchboard panels. This, combined with the absence of high-tension parts of apparatus from the front of the switchboard, renders all liability of the operator to shock or accident practically negligible.

The rear of the switchboard, as will be seen on reference to figs. 2 and 3, is divided into compartments by means of slate partitions. Thus each panel might be said to be a self-contained unit of which the rear compartment holds the high-tension apparatus and connections necessary for the operation of the switches, instruments, &c., mounted on the face of each panel. Each compartment is closed by an expanded-metal door provided with a simple device which interlocks it with the main isolating switch on the panel. Referring to fig. 1, the isolating switches will be seen enclosed in marble boxes screened in front with metal-expanded screens. The function of these switches is to cut off entirely a panel from the "live" bus-bars, thus making the inspection of that panel a perfectly safe matter. No person, therefore, can gain access to the apparatus at the rear of a panel unless the isolating switch is first opened, and it is then impossible to close the isolating switch until the door is closed.

The preceding description is illustrative of a high grade of switchgear, which, however, may be varied in constructive details to suit special requirements. Thus isolating plugs may be used in place of knife switches, in which case the main circuit-breakers would be interlocked with the doors at the rear of the panels, in such a way that access could not be gained to the rear of any panel until the *main* circuit-breaker had been opened. It would then be possible to remove the isolating plugs, and render "dead" all apparatus contained in the compartment. It will be noted that by this arrangement, it is impossible to open circuit on the isolating plugs while the current is flowing. Fig. 7, p. 725, illustrates this method of construction.

In the event of its not being desired to operate the switchboard continuously, the isolation and division of the switchboard into compartments may not be necessary, since it will then be possible to do all repairs and cleaning at periods when the switchgear is not in operation. Iron doors, however, would be provided for locking-up the passage way behind the switchboard.

For main and distribution switchboards operating at pressures above 3,000 volts, a class of construction and interlocking mechanism similar to that described above is adopted, except that more liberal spacings are allowed, and the compartments containing the high-tension apparatus, instead of forming the rear of the switchboard panels, are isolated and remote from the instrument and control panels.

The lay out of this switchgear is illustrated in fig. 8, but is subject to modification in structure as dictated by the kilowatt capacity of the plant to be controlled.

The main switches are closed through a system of mechanical levers by means of handles on the operating panel. The automatic release mechanism and instruments are operated from special transformers in a similar manner to those referred to in the above description of the switchgear for 3,000 volts.

The switchgear depicted in fig. 8 is a typical lay-out designed for operation at voltages up to 6,000.

For switchboards operating up to medium pressures, *i.e.*, not exceeding 650 volts, a standard panel construction is adopted, except that all live metal, if dictated by the requirements, is at the rear of the switchboard, the main quick-break knife switches being operated by handles projecting through the marble panels. In cases where it is necessary that a switchboard shall be kept in continuous operation, provision is made so that any particular section may be isolated in a manner similar to that described for the 3,000-volt gear, thus facilitating the carrying-out of repairs and cleaning, without risk to the attendant. Expanded metal doors may be provided to close in each section of the board, and, according to the exigencies of the case, interlocks may be arranged between the door and the main switch. Expanded metal doors are provided to close in the passage at the rear of the board, the locks on the door being arranged so that they may be opened from the inside of the passage without the use of a key. Fig. 9 shows an arrangement of switchboard for voltages up to 650, the assumption being that repairs, &c., will be carried out when the plant is shut down.

A similar class of switchboard is designed for continuous operation, as referred to above.

The above 650-volt type of board may also be supplied with standard knife blade switches, having the blades mounted on the front of the panels, in place of the back-of-panel tpye of knife switch in which all live metal is at the rear of the panel. Front and back views of a board of this description are given in figs. 5 and 6, p. 724.

It is apparent, however, that the adoption of a type of switchboard in which all "live" metal is at the rear of the panel is advisable, in so far as it eliminates the necessity of special enclosures and switch-rooms, and at the same time minimises the risks under the Employers' Liability Act.

(*To be concluded.*)

TELEGRAPH AND TELEPHONE NOTES.

(*Continued from page* 720.)

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Oran-Tangier-Cadiz	Oct. 30, 1905	..
Tenedos-Chio	Oct. 30, 1905	Oct. 31
Tenedos-Lemnos	Oct. 30. 1905	Oct. 31
Falmouth-Bilbao	Oct. 31, 1905	..
Trinidad-Demerara	Aug. 26, 1901	..
Dominica-Martinique	May 7, 1902	..
St. Lucia-Martinique	May 7, 1902	..
Cayenne-Pinheiro	Aug. 13, 1902	..
Reissa-Issa (Yemen) Camaran	Oct. 22, 1902	..
Tarifa-Tangier	Jan. 18, 1904	..
Closed { Vladivostock-Nagasaki	Feb. 9, 1904	..
Closed { Port Arthur-Chifu	Mar. 9, 1904	..
Jamaica-Colon	Jan. 5, 1905	..
Cadiz-Tenerif	July 20, 1905	..
Cotonon-Grand Bassam	Oct. 4, 1905	..
Puerto Plata-Martinique	Oct. 30, 1905	..
Alaska, via Seattle	Oct. 26, 1905	Oct. 29
Medan-Olehleh	Oct. 26, 1905	..
Landlines.		
Puerto-Barrios	July 28, 1902	..
Kertch-Soutehoum	Sept. 27, 1904	..
Communication with Brazil *via* Galveston	July 18, 1905	..
Rome-Constantinople	Oct. 27, 1905	Oct. 29.

Telephones to Cab Ranks.—The P.O. Telephone Department has arranged with the Committee of the Cabmen's Shelter Fund to connect the shelters with the Telephone Exchanges, so that subscribers can call a cab from the rank, but the apparatus is not to be used for any other purpose.

United States.—The organisation has been announced of the United States Independent Telephone Co., the purpose of which is to unite the various independent telephone companies in the United States, most of which have come into the new combination or have made working agreements. The territory covered by the new organisation extends from New York on the east to Salt Lake City in the west, and to St. Louis in the south. As to New York City, there are plans to revive an old licence, and to put in cables for a service of 225,000 instruments within two years. The New York telephone system has at present about 145,000 subscribers.

Reporting on the application of the Atlantic Telephone Co. for a licence to operate in New York City in active competition with the existing telephone trust, the city engineer has stated that the approximate value of the concession is £1,150,000 for a 25 years' lease. This is far in excess of the terms offered by the company.

Wireless Telegraphy.—A Reuter Pensacola telegram states that the cruiser *West Virginia*, with President Roosevelt on board, has been communicated with by wireless telegraphy at a distance of 300 miles. Naval officers are watching with considerable interest the experiments in maintaining communication with land throughout the voyage to Key West. Wireless telegraph stations have been installed at intervals all along the coast, with the view of keeping in closest touch with vessels. Plans are also being formulated to bring the Isthmus of Panama in direct touch with the United States. A Washington telegram states that a message from the *West Virginia* was intercepted there, telling the cruisers *Colorado* and *Pennsylvania* that she would probably join them at noon. This is stated to be remarkable, as the distance is 1,100 miles, mostly overland. Communication with the *West Virginia* lasted three hours, until the noise of work being resumed in the navy yard interrupted messages.

The U.S. Naval Department has succeeded in establishing wireless telegraphic communication between Colon and Guantanamo, a distance of about 700 miles.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—November 3rd. The Scottish Temperance Assurance Company, Belfast, is inviting tenders for electric lighting and fittings in its buildings. Specification on application to Mr. John Woodside, A.M.I.E.E., Ocean Buildings, Belfast.

Brazil.—December 16th. The municipal authorities of Sao Luiz (Maranhao), Brazil, are inviting tenders until December 16th for the electric lighting of the town.

Bristol.—Three-phase cables for the Corporation. See "Official Notices" to-day.

Cape Town.—November 22nd. Tenders are invited for the supply, to the Department of Posts and Telegraphs, of telegraph and electric light material. Tenders to the Chairman of the Tender Board, Control and Audit Office, Parliament Street, Cape Town. A notice appeared in the Cape of Good Hope Government *Gazette*, for October 3rd.

Cheshire.—November 3rd. Altrincham and Bowdon Administrative Sub-Committee for Education invite tenders for the electric wiring and fittings required for the Stamford Park New Council Schools. Plans and specification (deposit £2 2s.) from Jos. Howarth, Clerk to the Committee, Education Offices, Market Street, Altrincham.

Clacton-on-Sea.—November 6th. Gas engines and dynamos, switchboard, mains, battery, meters, crane, and buildings for electricity works, for the U.D.C. See "Official Notices" October 20th.

France.—November 9th. The French Post and Telegraph authorities in Paris are inviting tenders until November 9th for the supply of 15 lots of paper-insulated electric cables. Particulars may be obtained from, and tenders are to be sent to, Le Sous Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

Italy.—The municipal authorities of Sarzana are at present inviting proposals for the construction of an electric tramway between that town and Spezia.

Leith.—November 11th. The School Board invites offers for an electric light installation at Bonnington Road Public School. Specification, Mr. George Craig, architect, 85, Duke Street, Leith (£1 deposit).

Leyton.—November 16th. Engines with condenser; cooling tower, for the U.D.C. See "Official Notices" to-day.

Macroom.—November 10th. The U.D.C. invites tenders for lighting the streets of the town by electricity or acetylene gas.

Shoreditch.—November 7th. Water-tube boiler, superheater, piping, steel flue, &c., for the Electricity Department. See "Official Notices" October 27th.

Spain.—November 27th. The Spanish Ministry of Public Works is inviting tenders until November 27th, for the construction of an electric tramway in Madrid, from the Ronda de Valencia to the Glorieta del Puente de Toledo. Particulars may be obtained from, and tenders are to be sent to, La Direccion General de Obras Publicas, Madrid.

Walthamstow.—November 24th. Stores for the electricity and tramway departments for twelve months. See "Official Notices" to-day.

CLOSED.

Blackpool.—The tender of Messrs. J. W. Fielding and Co. has been accepted for installing the electric light at the new North-Western Co-operative Convalescent Home, at Blackpool.

Bolton.—The Corporation Tramways Committee has accepted the tender of Messrs. Burrows & Son for the erection of tramway offices.

East London (S.A.).—The tender of Messrs. Howard, Farrar, Robinson & Co., Ltd., of East London, (£271 13s.) has been accepted for the wiring of the new building for the Bank of Africa, Ltd. This was the lowest tender, the highest being that of Messrs, Green & Trevett, of Cape Town (£498 19s.). The work comprises wiring for 95 points and for one 1-H.P. motor, in screwed insulated conduit; also the supplying and fixing of fittings and eight meters, main switchboard, &c.

At a special meeting of the Electric Lighting Committee the following resolutions were agreed to, and they were afterwards ratified by the T.C.:—That an order be placed with Messrs. Kelvin and James White, Ltd., of Glasgow, by cable, through the London agents, for certain specified spare instruments required in the power house; that a supplementary vote of £555 be passed in respect of the surface condenser; and that the scheme outlined by the Electrical Engineer for additions to, and alterations at, the power house, involving an expenditure of £17,550, be considered and reported upon by that official in conjunction with the Town Engineer.

Eccles.—The T.C. has accepted the tender of Messrs. R. J. Nicholson & Co., Ltd., for the installation of the electric light in 46 working-men's dwellings, at £138.

France.—La Société Industrielle des Telephones, of Paris, has secured a contract from the French Post and Telegraph authorities for the supply of 120 kilometres of telephone cable with one pair of conductors, and 20 kilometres ditto with 56 pairs of conductors.

Islington.—The Lighting Committee has provisionally accepted the tender of Messrs. Phillips & Co., Ltd., to supply 5,000 tons of bituminous nutty slack coal, at 2s. 6d. per ton at the pit's mouth, and 9s. 3d. per ton delivered.

London.—The L.C.C. have received the undernoted tenders for the supply of 4,210 tons of acid steel track rails and fastenings to be used in connection with the reconstruction of the first section of the northern tramways:—

Lorain Steel Co.		£27,121
Bolckow, Vaughan & Co.	(accepted)	31,131
Barrow Hæmatite Steel Co.		32,249
P. & W. Maclellan		32,813

The lowest tender was not in accordance with the specification. The successful company has been authorised to sub-let the manufacture of the fish bolts and nuts to Guest, Keen & Nettlefolds, Ltd.

Middlesex.—The County Council received the following tenders for the construction of the Bounds Green Road, Wood Green and Southgate tramway:—

T. Adams		£39,818
G. Bell		40,235
British Electric Equipment Co. ..		37,488
Dick, Kerr & Co.		38,387
Ford Clift		38,387
Wm. Griffiths & Co.		37,980
Grounds & Newton		41,873
G. Hay & Co.		40,834
G. Holloway		39,800
Mowlem & Co.		42,024
F. Osman		38,500
Pethick Bros.		39,777
J. Strachan		50,700
C. Wall, Ltd.		44,319
Wimpey & Co.	(accepted)	35,884

The County Engineer's estimate was £38,911 14s. 7d.

Salford.—Messrs. S. Dixon & Son, Ltd., have received an order from the Corporation for one Turner's patent automatic point controller.

Wellington, N.Z.—On the recommendation of its Tramways Committee, the Council has accepted the tender of the Electrical Construction Co. for the supply of power house machinery, at £9,400, and the tender of Messrs. Rouse & Hurrell for two combination cars, at £425 each. The Corporation has also accepted the following tenders in connection with tramway construction work:—Tramway bonds, Messrs. J. Duthie & Co., £166; tramway rails, Messrs. J. Duthie & Co., £4,332; points, crossings and special work, Hadfield's Steel Foundry Co., Sheffield, per the Wellington agents, Messrs. Richardson & Blair, £422.

FORTHCOMING EVENTS.

To-day's Events (Friday, November 3rd).—At 8 p.m. Junior Institution of Engineers. Presidential Address by Mr. D. Clerk on "The Problem of the Gas Turbine."

Saturday, November 4th.—At 7.30 p.m. Glasgow Technical College Scientific Society. "Electric Power Plant Design," by Mr. P. D. Ionides.
Birmingham and District Electric Club. Mr. J. H. Stansbie on "Electric Furnaces."
At 3.0 p.m. At the Birkbeck College, London. The Annual General Meeting of the Association of Teachers in Technical Institutes, to discuss the annual report and proposed amendments to constitution and rules, to elect officers and Council, and other business.

Monday, November 6th.—At 7.30 p.m. Society of Engineers. Mr. S. Cowper-Coles on "The Metallic Preservation and Ornamentation of Iron and Steel."

Tuesday, November 7th.—At 8 p.m. Institution of Civil Engineers. Inaugural Address by the President, Sir Alexander R. Binnie. Presentation of the Council's Awards, and Reception in the Library.

Thursday, November 9th.—At 8 p.m. I.E.E. Meeting at the Institution of Civil Engineers. Presentation of premiums awarded; Presidential Address by Mr. John Gavey.

Friday, November 10th.—At 8 p.m. Physical Society. Meeting at Royal College of Science. Mr. James Swinburne on "The Question of Temperature and Efficiency of Thermal Radiation."

Tuesday, November 14th.—At 8 p.m. I.E.E. (Glasgow). Meeting at the Institution of Engineers and Shipbuilders.
At 8 p.m. Institution of Civil Engineers. Mr. J. A. Saner on "Waterways in Great Britain."

During November.—Tramways and Light Railways Association. Lecture on "The Paving of Roadways." Visit to Holborn and Strand Subway.

THE ELECTRICAL ENGINEERS R.E. (VOLS.).

The following orders are issued:—

Monday, November 6th.—"A" Company, technical work 6 to 10 p.m.
Tuesday, November 7th.—Medical examination and enrolment of recruits at 7 p.m. "B" Company, technical work 6 to 10 p.m.
Thursday, November 9th.—"C" Company, technical work 6 to 10 p.m., for men who have not obtained "A" Badge and recruits.
Friday, November 10th.—"D" Company, technical work 6 to 10 p.m.

WILFRID C. DUMBLE, Captain R.E.
For O.C.E.E.R.E. (V.)

U.S. Customs.—The Allis-Chalmers Co. recently imported into the U.S.A. some models of turbine machinery, which the Customs officials assessed at 45 per cent. *ad valorem* as "manufactures of metals." The Allis-Chalmers Co. claims that they are patterns and is appealing against the assessment.

NOTES.

The British Association.—The General Committee has resolved to accept the cordial invitation from Leicester to hold its 1907 meeting there.

Gas.—The death of a child, and the narrow escape of her father, from suffocation, were caused by a partly turned on gas jet at Cleethorpes on Saturday morning.

On the same day at Burnley two men were rendered unconscious, one of them having since died, an escape of gas from a defective bracket being the cause.

A new gas main has lately been laid throughout the centre of the town of Penrith. Last Saturday, while connections were being made to various premises, a serious explosion occurred in the basement of a draper's shop, wrecking the interior and injuring several people.

Wireless Telegraphy.—Judge Wheeler, on October 16th, 1905, rendered a decision in the suit of the National Electric Signalling Co. (Fessenden system) against the De Forest Co. for infringement of the liquid barretter. The decision is in favour of the complainant. The following claims are sustained:—

"11. An electrical receiver consisting of a liquid and an extremely fine terminal projecting into the liquid, substantially as set forth.

"23. In an electrical wave detector, the combination of a liquid and a terminal projecting thereinto and having in the liquid so small an immersed area that a highly resistant layer is formed about the terminal, substantially as described.

"25. As a telegraphic receiver, the combination of liquid and an extremely fine terminal projecting into the liquid, and so arranged that the passage of an electric current will produce thermal effects in the liquid, substantially as described."

The other claims were not passed upon.

This decision is of considerable importance, as it establishes the ownership of the fine-point liquid receiver, which is now used by the National Electric Signalling Co., De Forest Co., Shoemaker, Slaby-Arco and other companies. This receiver was used by the signal corps for their Alaska installation and by the De Forest Co. in its installation on the Haimun in the Russo-Japanese War, and in the tests made by the same company in England. With the exception of the Marconi magnetic receiver, it is at present the only receiver used for long-distance work, and several hundred stations are now equipped with it. In the United States Navy official test, a distance of more than 2,000 miles was obtained by its use from shore to ship, under unfavourable circumstances, and a distance of 320 miles was obtained on an official test during daytime, between the Illinois and Alabama by its use with the expenditure of ½ H.P.

Institution Notes. — I.E.E. (Glasgow Section) Dinner.—The fourth annual dinner of this section was held in the Grosvenor Restaurant on October 27th, and proved one of the most successful functions ever held under the auspices of the section. Mr. John M. M. Munro, president of the section, occupied the chair, and the company, which numbered over 200 gentlemen, included Lord Kingsburgh (Lord Chief Justice Clerk of Scotland), Sir John Ure Primrose, Bart., Lord Provost of Glasgow, Messrs. Robert Kaye Gray, G. C. Lloyd, and E. George Tidd. The croupiers were Messrs. Walter Dixon, W. W. Lackie, Frank A. Newington, Henry A. Mavor, Magnus M'Lean and John Macfee. After the loyal toasts had been honoured, Sir John Shearer proposed "The Imperial Forces." Lord Kingsburgh responded with a number of interesting reminiscences. Sir John Ure Primrose, Bart., submitted "The Institution of Electrical Engineers," and in doing so, said that in speaking of electricity he entered a field which was not only interesting and intensely valuable, but was a realm that partook of romantic charm, and at the same time was of immense potentialities in their future economy. They could hardly conceive that 25 years ago that wondrous potency was only emerging from the laboratory and was only in its earlier stages being perfected by the scientific brain.—Mr. R. Kaye Gray replied. In the course of his remarks he expressed the regret of the president of the Institution at his inability to be present that evening. Proceeding, he said, that in Glasgow they were to be congratulated on the liberal spirit with which electrical enterprise was dealt with, and taken full advantage of. No body had done more in this direction than the Corporation. He had been charged to say that the papers contributed by the Glasgow local section to the Institution were of unusual merit. The only point the Council would like to have improved in Glasgow was the looking after of the younger men. In Manchester, for instance, they had a large section of students, and in Glasgow they were forming a similar section, and after they had got over the difficulties which came their way, the section would thus be made stronger than ever. The chairman in responding to the toast of "The Glasgow Section," said they were very much indebted to those who had come there that night encouraging them at the beginning of a new session. They had heard that the students of Glasgow had not taken a sufficient interest in the development of the Institution. Whatever means there might be found for them to meet together later on, in the meantime, it had been arranged that they meet alone. During the evening songs and readings were rendered by members of the company.

Institution of Electrical Engineers (Cape Town).—At a meeting of the Cape Town Local Section held at the South African College on September 27th, the paper on "Earthing" (already read at Glasgow by Mr. Lackie) was read by the hon. secretary, and discussed by the members present. The opinions expressed were unanimously to the effect that it would be impracticable in Cape Town to insulate effectually electrical conduits from metal work and gas and water pipes in new buildings (as suggested by Mr. Lackie), especially in view of the large amount of steel girders and metal lathing used in the American style of building now mostly in favour in the district. Earthing through a resistance was also considered unnecessary, and as likely to add materially to the cost of a wiring installation.

Faraday Society.—The following papers were read at a meeting held on Tuesday last:—"Alternate Current Electrolysis as shown by Oscillograph Records," by Mr. W. R. Cooper. "Note on the Crystalline Structure of Electro-deposited Copper," by Prof. A. K. Huntington; "Some Observations Respecting the Relation of Stability to Electrochemical Efficiency in Hypochorite Production," by Mr. W. Pollard Digby. A paper by Prof. Ernest Wilson on "Alternate Current Electrolysis" was discussed.

I.E.E. (Leeds).—On Wednesday last week the inaugural address of this section was delivered by Mr. A. B. Mountain, M.I.E.E. He referred briefly to the development of electricity supply undertakings during the last 10 years, with some conclusions to be drawn from the approximate figures placed before them. At the end of 1894 there were 60 undertakings, with a capital expenditure of £6,107,680; at the end of 1904 there were 445 undertakings, with a capital expenditure of £61,961,313. The consuming devices, reduced to the equivalent of lamps connected, in 1894 numbered 2,031,398; and at the end of 1904—19,971,435. The units sold in 1894 numbered 30,203,766, and in 1904—448,078,057. The average price obtained per unit sold in 1894 was, by companies, 6·08d.; and by municipalities 5·32d.; in 1904 the average price obtained by companies was 3·9, and by municipalities 2·7. The capital expended and lamps connected had each increased proportionately by 10 times, and the units sold by nearly 15 times, while the price obtained had decreased by 48 per cent. The conclusions which he thought might be drawn from his very brief glance at the progress of electric supply undertakings were that greater care must be exercised in the expenditure of capital, that the introduction of large generating plants would lead to ultimate economy, and would enable them to compete with the comparatively small engines employed for driving factories, and that reduced charges would still further enormously increase the output of energy for both lighting and motive power purposes, if they by exhibition or other practical demonstration showed the actual advantages to be derived from the use of electricity.

Tramways and Light Railways Association.—A party of about 30 members paid a visit on Tuesday afternoon to the power station of the North Metropolitan Electric Power Supply Co., at Brimsdown.

Leeds Association of Engineers.—At a meeting of this Association on 26th ult., a lecture was delivered by Mr. Percy Rosling on "The Economics of Electrical Driving."

Appointments Vacant. — Electrical engineer and manager of the light railways for Barking Town U.D.C. (£225); collector (£3) and accounts clerk (35s.) for Marylebone.

Electrical Manufacture of Rivets.—Messrs. Macfarlane and Whitfield, of Dunston, following the lead of the larger steel manufacturers and colliery proprietors, but leading so far as their own business is concerned, have just had completed an electrical installation for the manufacture of rivets, and in connection with this plant an interesting ceremony took place on Wednesday afternoon last. The large engine and its accompanying electric generator were started by Mrs. Whitfield, while several other machines were started by other ladies. The party subsequently adjourned to Mr. Whitfield's residence, where the healths of the firm and the contractors were cordially drunk. Mrs. Whitfield was presented with a silver kettle by Mr. Cecil A. Esmarch, the resident engineer for Messrs. Bruce Peebles & Co., Ltd, the contractors. The gas engine and plant of 115 B.H.P. was provided by Messrs. Crossley Bros., the sub-contractors.

NEW COMPANIES REGISTERED.

Saxby & Farmer (India), Ltd. (86,274).—This company was registered on October 26th, with a capital of £50,000 in £1 shares, to acquire the factory of Heath & Gresham, Ltd., at Calcutta, and to carry on in any part of the world the business of railway signal and interlocking apparatus manufacturers and contractors, machine and tool makers, millwrights, mechanics, ironfounders, compressor manufacturers, metallurgists, refiners, smelters, engineers, makers of and dealers in pneumatic and electric tools and appliamces and signals, producers, storers and suppliers of heat, steam, compressed air, oil, gas and electricity, &c. The first subscribers (each with one share) are:—C. Hodgson, 53, Victoria Street, S.W., chairman of Saxby & Farmer, Ltd.; G. Terrell, 38, Albion Street, Hyde Park, W., director of Saxby & Farmer, Ltd.; W. Wingfield, 2, Ryder Street, S.W., director of Saxby & Farmer, Ltd.; D. E. Norton, Laurel Dene, Hampton Hill, Middlesex, director of Saxby & Farmer, Ltd.; R. Payne, 53, Victoria Street, S.W., secretary of Saxby & Farmer, Ltd.; J. F. Pickard, 53, Victoria Street, S.W., accountant to Saxby & Farmer, Ltd.; and F. Varley, 14, Copthall Avenue, E.C., solicitor. No initial public issue. The number of directors is not to be less than two nor more than six; the first are C. Hodgson, G. Terrell and W. Wingfield; qualification, £100; remuneration, one guinea each per board meeting attended.

Telegraphic Code Co., Ltd. (86,295).—This company was registered on October 28th, with a capital of £2,000 in £1 shares (1,500 preference), to carry on the business of authors, compilers, adaptors, publishers and sellers of telegraphic codes or secret cyphers, &c., and to adopt an agreement with J. G. Schütte. The first subscribers (each with one pref. share) are:—J. G. Schütte, 75, Cheapside, E.C., code expert; H. Peakes, Ravenscroft, Woodridings, Hatch End, Middlesex, secretary; F. Haddrell, Lawn Road, Uxbridge, Middlesex, secretary; F. E. D. Acland, Walwood, Banstead, Surrey, civil engineer; F. D. Marshall, 7, East India Avenue, E.C., ship broker; E. R. Lindley, Holders Hill House, Hendon, Middlesex, average broker; and G. Loly, Quernmore, Bromley, Kent, schoolmaster. No initial public issue. The number of directors is not to be less than two nor more than seven; the subscribers are to appoint the first; qualification, £100. Registered office, 2, Royal Exchange Buildings, E.C.

OUR PERSONAL COLUMN.

[*The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the* Electrical Review *posted as to their movements.*]

Central Station Engineers.—Mr. Arthur Hugh Seabrook, electrical engineer at Barking, has been appointed electrical engineer at West Ham. There were 73 applicants.

Mr. T. C. Margary, senior mains engineer at Islington, having completed satisfactorily six months on probation superintending the mains work, has been permanently appointed to the latter position at a salary of £200.

Mr. J. Allward, senior shift engineer at Islington, has been appointed, on probation for six months, station superintendent at a salary of £180.

Mr. T. Beaumont was, on Wednesday last, presented with a slide rule by the generating staff of the Woolwich Borough Electricity Undertaking, as a token of their respect. He leaves to take up an appointment in the Bradford Corporation Electricity Works.

Mr. G. E. Wintle has resigned his position at the Ipswich Corporation Electricity Works, having been appointed Station Superintendent for the Maidstone Corporation Electricity Supply and Tramways Station. He takes up his new duties on Wednesday, November 8th.

Tramway Officials.—The staff of the Peterborough Electric Traction Co. have presented Mr. Coomber, the retiring manager, with a case of silver-plated fish knives and forks and a pair of silver salt cellars. Mr. Coomber is leaving for Belfast.

The Gloucester T.C. has decided not to combine the offices of tramway manager and electrical engineer, but to appoint a general manager for the tramways.

Mr. R. R. Fairbairn, tramway manager, has been re-elected, unopposed, a member of the Worcester City Council.

Mr. Phipps, who has been appointed overhead inspector of the Belfast Corporation Tramways, has been presented by the staff of the Scarborough Tramway Co. with a silver cigarette case.

The employés of the Scarborough Tramway Co. have presented a marble clock to Mr. Nicoll, secretary to the company, on his marriage.

From Monday last the office of Mr. J. Wilkinson, tramways electrical engineer, Hull, has been removed to Queens Dock Chambers, Alfred Gelder Street, Hull, where all correspondence referring to the department should be sent.

General.—Mr. Theodore Rich, lately with Bruce Peebles & Co., Ltd., and also well known as an officer in the Electrical Engineers Volunteers, has taken up a position in the Soudan Public Works Department. Mr. Rich carries with him the best wishes of many friends both in London and in the provinces.

The *Australian Mining Standard* says that Mr. Roger Wallace, K.C., chairman of the Kalgoorlie Electric Power and Lighting Co., has been in Kalgoorlie to consider the conditions before completing the final arrangements between the company and the Kalgoorlie Tramways Co.

It is announced that the Postmaster-General has appointed Mr. A. E. Eames (senior assistant controller) to be Controller of the Central Telegraph Office, and Mr. J. Newlands (formerly of Edinburgh) to be Deputy-Controller, in place of Mr. E. Trenam, I.S.O., and Mr. J. W. Eames, retired. At St. Martin's-le-Grand on Tuesday afternoon a testimonial, subscribed for by his London and provincial colleagues, was presented to Mr. E. Trenam, I.S.O., upon his retirement on a pension after 49 years' service. The presentation took the form of a gold watch and chain, and a diamond ring for Mrs. Trenam. Mr. H. Babington Smith (secretary to the General Post Office) presided and made the presentation. Later in the day, says the *Times*, Mr. J. W. Eames, who also after 49 years' service retired on pension from the position of Deputy Controller, likewise received a testimonial from his late colleagues. This consisted of a silver salver, a salad bowl service, a biscuit box, a drawing-room clock, and a silver photo frame. Mr. A. J. S. Adams made the presentation, afterwards handing a testimonial to a third retiring telegraph officer, Mr. C. A. Morgan, assistant controller technical branch. To him, on retiring after 45 years' service, his colleagues presented a silver watch, biscuit box, and butter knife.

Mr. Arthur Willmott, A.M.I.E.E., who has for the past 2¾ years been assistant works manager of the Jandus Electric Co., London, N., has now joined the staff of the G.E.C. at their Witton Works.

The staff at the Electric Construction Works at Bushbury, Wolverhampton, has presented a marble timepiece, a pair of bronzes, and a purse of gold to Mr. Richard Jones, late manager of the works, who is retiring after 25 years' service.

Mr. Wilfrid L. Spence, Assoc.M.Inst.C.E., M.I.Mech.E., informs us that he resigned last month the office of engineer to, and managing director of, the British Electric Plant Co., Ltd., Alloa, and that he is practising as a consulting engineer at 31, St. Vincent Place, Glasgow. (Tel. No. 1,500 Royal; telegrams, Electrify, Glasgow.) Mr. Spence will specialise on matters electrical and electro-mechanical.

The governing body of Battersea Polytechnic, S.W., has appointed Mr. E. G. Tottle, M.I.M.E., to the post of superintendent of the drawing office and workshops in the Department of Mechanical Engineering in the Battersea Polytechnic. Mr. Tottle has had considerable experience as mechanical and electrical engineer, both in the workshops and drawing offices. He is at present on the teaching staff of the Chiswick Polytechnic and the Welcome Institute, Deptford.

In the early hours of Wednesday morning a very large gathering of employés (1,300) of the London United Tramways Co. was held at the Chiswick car-shed. Mr. Cater Scott, the chairman of the company, presided. After supper an illuminated address was presented to Sir J. Clifton Robinson, the managing director, congratulating him upon his knighthood. A piece of plate was presented to Lady Robinson.

Mr. Francis H. Davies is leaving the British Westinghouse Co. to take up an appointment in the Electricity Department of the Marylebone Borough Council.

Mr. J. Archibald Kyle, A.I.E.E., is shortly leaving the Aron Electricity Meter, Ltd., where he has held the position of assistant engineer and technical representative for the last three years.

ELECTRIC TRAMWAY ACCOUNTS.

Manchester Corporation Tramways.

The returns of the Manchester tramways department have now an added interest, in that they are representative of our most extensive tramway system, in point of route mileage. The 84 miles of route include 20 miles of leased lines, and 2½ miles over which the Corporation exercises running powers. Although this mileage eclipses that of the generally accepted ideal, Glasgow, much leeway remains to be made up, before the 195,767,519 passengers and £764,790 revenue of the latter, on a 10 miles shorter route, can be equalled.

General Statement.

For 12 months ending March 31st	1905.	1904.
Length of route	84 miles.	79 miles.
Total length of track	146¼ "	137¾ "
Average number of cars in use	—	447
Car-miles run	14,123,124	13,617,448
Passengers carried per annum	126,900,875	120,772,368
Capital expended to date	£1,587,931	£1,485,612
Traffic receipts	£628,529	£603,182
Total receipts	£631,955	£611,881
Working expenses	£411,597	£391,854
Gross profit	£220,358	£220,027
Income per car-mile	10·73d.	10·67d.
Working expenses per car-mile	6·99d.	6·78d.
Interest and sinking fund per car-mile	1·49d.	1·40d.
Rental of leased lines	·18d.	·37d.
Total expenses per car-mile	8·66d.	8·55d.
Profit or loss per car-mile	2·07d.	2·12d.
Cost of energy per car-mile	1·99d.	1·84d.
Average fare per passenger	1·19d.	1·2d.
Revenue per mile of route	£7,523	£7,745
Expenditure per mile of route	£4,899	£4,968
Total units used	18,854,240	16,815,764
Units used per car-mile	1·33	1·23
Percentage of working ex'es to receipts	65%	64%

The average working expenses are somewhat above last year's figure amounting to 6·99d. per car-mile, a creditable figure when it is remembered that it includes 1·99d. per car-mile for energy amounting to some 19 million units at 1·49d. per B.T.U. purchased from the electric lighting department. That the latter department, is by no means a loser on the transaction, can be better realised by a comparison with the Glasgow power statistics, where on a calculated output of 23 million units (20 millions only of which were for traction) the average price per unit amounted to 1·13d. including ·37d. for depreciation and ·42d. for interest and sinking fund on the power plant. The Glasgow tramways department, of course, owns its own power plant, and benefits correspondingly.

The following are the principal items of working expenditure for the past year:—

Traffic expenses		3·13d.
General "		1·00d.
General repair and maintenance—		
Permanent way	·16d.	
Electrical equipment of line	·099d.	
Buildings and fixtures	·010d.	
Machinery and plant	·017d.	
Cars	·57d.	
Other rolling stock	·014d.	
		·87d.
Power expenses		1·99d.
Total working expenses		6·99d.

The gross profit on the year's working amounted to £220,358, which, together with bank interest £1,869, produced a sum sufficient to meet all financial charges and leave a surplus of £120,950.

The latter was allocated much as in 1904, being as follows:—

Renewal and depreciation account	£70,907
Contribution in aid of rates	46,000*
Interest on street improvements, &c.	4,043
	£120,950

* This amount was increased by £5,000 transferred from an accumulated reserve, making a total contribution to the rates of £51,000.

The general manager, as in previous years, was Mr. J. M. McElroy.

Profit Statement, 1905.

Interest, &c.	£52,120
Sinking fund	35,379
Rental of tramways, leaseholds, &c. ...	10,795
Income-tax	2,983
Surplus	120,950
Gross profit (and bank interest accumulated)	£222,227

CITY NOTES.

Westminster Electric Supply Corporation.

Meetings of holders of preference and ordinary shareholders, also an extraordinary general meeting of the company, were held at Eccleston Place on Tuesday, to consider the capital proposals of the directors, whose purport was embodied in the resolutions printed on page 689 of our last issue. Lord Suffield presided.

At the first meeting (preference holders) Mr. Hayes Fisher explained the proposition of the board, and said that the purpose of the meeting was to take power to raise such additional capital as after a careful estimate they thought would be necessary during the remainder of the company's concession, *i.e.*, during the next 26 years. The present expenditure of capital might roughly be taken at £1,000,000, and they contemplated the expenditure of a further £1,000,000. Of this sum they would require to spend one-fourth, or £250,000, during the next few years. This they proposed to issue at once in preference shares. That the shareholders might better understand the position of the company, he would briefly set out its financial history from its foundation by a provisional order for 42 years from August, 1889. This had run 16 years in August last. It, therefore, would expire in August, 1931, *i.e.*, it had 26 years still to run. This was the governing factor in raising any further capital. They started their business in 1889 with £100,000 in ordinary shares. There were no preference and no debentures. By 1893 the share capital had been increased to £300,000 ordinary shares, on which a 4 per cent. dividend was paid, and £100,000 mortgage debentures bearing interest, some at 5 and some at 4½ per cent. By 1898 the share capital had been raised to £400,000, on which a dividend of 12 per cent. was paid, while the old debentures (£100,000) had been paid off, and new debentures to the extent of £200,000 at the reduced interest of 3½ per cent. had been substituted. By 1902 the ordinary capital had been raised to £550,000 (at which it now stood) and a dividend of 12 per cent. paid; the debentures to £250,000, at which also they stand to-day; and 5 per cent. preference shares to an amount of £140,755 had been issued. The dividends for the past two years had been 13½ and 14 per cent. on the ordinary shares. This worked out at an average of 8⅝, or £8 8s. per cent. to the original shareholders. The ordinary man in the street who read that last year the shareholders received 14 per cent., probably concluded that those who had found the money to light the City of Westminster were making inordinate profits. Let them examine this. To produce the excellent light now given, and the power, the demand for which was rapidly expanding, £1,000,000 had been spent. Broadly speaking, a fraction over 4 per cent. had been paid on half that amount, and (if they took the average dividend over the whole period) less than 8½ per cent. had been paid on the other half; so that the real substantial truth was that the ordinary consumer in Westminster who was a ratepayer had run no risks with his money as a ratepayer, and had had an excellent supply of light at a price which had not been at any time dear, and would, they hoped, become considerably cheaper, especially as the demand for a day load—*i.e.*, mainly power—gradually developed. Turning next to the expenditure of the company: at the end of 1891, £297,640 had been expended; of 1894, £411,000; of 1898, £626,365; 1902, £951,806; 1904, £1,065,000. At the present time expenditure was £1,097,000. The share capital and debentures issued were £941,255, and they had overspent on capital account £155,700. This was not a sum borrowed from bankers, because out of the profits of the company the directors had each year made what they were advised were proper allowances for depreciation. This depreciation fund had been invested in the company's business, which had rendered unnecessary until now the issue of further capital. They felt that, however sound this policy might have been in the past, looking to the fact that they were so many years nearer to the end of their concession, the time had now arrived when they should commence to invest this fund in securities outside the company's undertaking, so as to be available in case of necessity. From this review of past capital expenditure, it would be seen that the history of the company was one all along of increased demands for its product and gradual progressive expanse of capital to meet that demand. Formidable, therefore, as the present proposal for future capital might appear, it was only following on the lines of past experience. Guided by this past experience, and acting on the advice of the officials of the company and of the company's brokers, the directors had surveyed the field of their future operations, and considered that the time had now arrived to make arrangements for providing the further capital required from time to time during the remainder of the company's concession, which it was estimated would amount to £1,000,000. Now, for what did they require this large sum of money? He would briefly explain. The demand for current showed no signs of diminishing; it was being used now for many more purposes than formerly, and the increase was greater in the current sold at the lower rates. In fact, increase of business appeared to depend largely on the rate at which they could afford to sell. Within the last few years a considerable demand for power had sprung up. Leases were falling in in a large part of their area at present almost untouched, and as new buildings were erected they required a supply. Other sources of demand were almost certain to arise, and it was by no means improbable that their output at the end of their term might be three times what it was now. To meet this two more transformer stations of about the same capacity as Duke Street would be eventually required, part of which must be put in hand almost immediately. Provision had also to be made for the mains department within the next few years in connection with which it was suggested that stores should be erected at Eccleston Place. There was still a considerable balance on account of Duke Street to be paid. The other two stations would probably cost very much less than Duke Street, but taking it all round, it could hardly be said that less than £150,000 would be required for land and buildings by the end of their term. Plant and machinery to equip these three transformer stations would cost approximately £200,000. They had already spent nearly £400,000 on mains, and taking high-tension feeders into account they might expect to spend another £500,000 under this heading. For meters they had spent nearly £60,000, and would probably spend nearly another £100,000, while £20,000 or so might be required for street lighting if the local authorities decided to extend the present very satisfactory system of arc lighting. These figures could, of course, only be taken as rough guides to the amounts which would probably be required, but they were sufficient to show that they might expect to expend something like another £1,000,000 capital by the end of their term, while it was possible that new developments might increase this considerably. Of this sum £200,000 to £250,000, or nearly one quarter, would probably be required within the next few years. As the increase of the business depended so much on the rates charged, their success must largely rest on their ability to raise this additional capital at as low a rate of interest as possible. The directors had power to issue further mortgage debentures, or to create a debenture stock, but they considered it to be in the interests of the shareholders of both classes to create a security that would rank equally with the present preference capital instead of before it. The present mortgage debentures fell due for repayment in 1920, and it might then happen that they could not be replaced without an increased interest and the provision of a sinking fund, which would be a much heavier charge on the revenue of the company than that entailed by the increase of capital now proposed. Of course it was possible to have obtained the required capital by the issue of ordinary shares at par or at a premium, but having carefully considered the matter during the past six months, and having consulted with the company's brokers, the board had unanimously come to the conclusion that the proposed re-arrangement of the company's capital account was best in the interests of both classes of shareholders. They, therefore, recommended that the authorised amount of share capital be increased to £2,000,000, divided into £1,000,000 cumulative preference share capital, and £1,000,000 ordinary share capital; the £1,000,000 preference capital to carry a preferential right over the ordinary shares of the company in the distribution of the assets in the case of the winding up of the company, and a *pro rata* share of any surplus after repayment of ordinary capital at par. It was proposed that the preference shares of the company for the time being issued should carry a cumulative preference dividend of £4 10s. per cent. per annum, instead of £5 per cent. per annum, and that the holders of the £140,755 of 5 per cent. preference shares (No. 110,101 to 138,251) be allotted an amount of £15,640 in 3,128 preference shares of £5 each to be paid for by a bonus free of income tax out of the reserve fund of the corporation. What would be the effect of these proposals if adopted by the shareholders? The present holders of debentures would find their position strengthened, as the new capital raised at a cheap rate would be put into a remunerative business. The present preference shareholders would receive the same interest as formerly on their holding with an addition of 11 per cent. to their capital; while the ordinary shareholders would reap the benefit of the new capital invested in the business of the company at a low rate of interest, and they were advised that as soon as this was appreciated by the inventing public the market for both classes of shareholders would be strengthened. As to procedure for carrying out the proposals, the directors proposed that an amount of £250,000 preference share capital be alloted to existing shareholders (ordinary and preference) *pro rata* to their present holding at three-eights (7s. 6d.) premium per share. The premium received would be placed to reserve and be applied to cost of conversion of existing preference shares from 5 per cent. to 4½ per cent., and other expenses. The balance of the capital to be retained and issued as the needs of the company required. The allotment would be in the proportion of one new share to three now held payable as to £1 7s. 6d. in December next, and the balance of £4 per share at the end of March, 1906. Interest would accrue on any shares paid up in full on January 3rd next. They further proposed that the bonus shares for the conversion of the present 5 per cent. preference shares (No. 110,101 to 138,251) to 4½ per cent. should be issued in January. Fractions of shares could be issued so that all shareholders would receive full value, and

arrangements would be made so that fractions might be made up to full shares, or the difference paid in cash. He trusted that this review of the position of the company had enabled shareholders to grasp the situation in which their directors found themselves, and that the proposals would meet with cordial and unanimous approval.

Lord KINNAIRD seconded the adoption of the following resolution :—

That as from December 31st, 1905, the preferential dividend payable upon the preference shares of the company be at the rate of 4½ per cent., instead of at the rate of 5 per cent. per annum, and the rights of the holders of such shares be and are hereby modified accordingly.

Sir DIXON HARTLAND said he understood that they would only at present issue £250,000 at 4½ per cent., but would the other £750,000 be issued by the directors without appealing to the shareholders at all, or would they be called together so that they would know what was going on, before giving a blank cheque to the directors?

In reply, it was stated that the board would be bound to call the shareholders together for any large sum, but not for a matter of, say, £30,000.

Sir DIXON HARTLAND said that they proposed a large expenditure of one million, and he wished to refer to the Power Bill brought into Parliament last session. He was one who did his best to oppose it in the interests of private companies, and they got rid of it. He would be prepared to help the company again in any way he could. But would that Bill, if passed next session, have a very great effect upon the company's business? Were there so many works in the company's area that the Power Co. would come in and rather cut out their business, so that it might not be necessary to issue so much capital?

Mr. HAYES FISHER, in reply, said that the board thoroughly appreciated the importance of Sir Dixon Hartland's point regarding the struggle between this and other companies and the County Council to enter this company's area for the supply of power. He believed that one of the best means of preventing them getting in was to gradually expend their own capital in strengthening their works, so that they could supply power cheaply. They had just signed the first contracts for power supply at 1d. per unit. Prof. Kennedy, their engineer, was of opinion that they would be able to compete with anyone in their own area for supply of power at a cheap rate if they took the proper steps to do it. The present scheme of the directors was part of the procedure necessary to effect that object, and so they asked for power to raise that extra capital. Shareholders in that and other companies could very largely aid their efforts in Parliament by instructing the public as to what was in their best interests. They should not divorce the capacity to supply power from the capacity to supply light. If they wanted light cheaper in the future, they must increase their day load. In the interests of the public, those companies which were strong and first in the field should be given a fair opportunity of supplying power at a cheap rate as a day load. They could thus supply light at a cheaper rate.

Mr. PALGRAVE SIMPSON said he originally had objections to the proposition of the directors. They all knew the danger of over-capitalisation, and he was very glad to hear from Mr. Hayes Fisher that only one-fourth of the share capital was to be raised at once.

Mr. HAYES FISHER said that it would be sufficient for the next few years as far as they could see.

Mr. PALGRAVE SIMPSON said that to have issued a million would have had a very deteriorating effect upon the present market price of the existing shares. The only thing he would like to ask was, would the income of the company and the improvement of business enable them to easily pay a dividend at something like the same rate as hitherto, when the additional £250,000 shares were issued, on the ordinary shares?

Mr. HAYES FISHER said that they had every reason to believe that they could pay the 4½ per cent. preference dividend, and continue to pay the same ordinary dividend. They fully hoped so.

The resolution was then put and carried unanimously.

The meeting of ordinary shareholders was next held, and the following resolution was proposed :—

That this meeting hereby sanctions the distribution among the holders of preference shares already issued at the date of this meeting, of the sum of £15,640, free of income-tax, out of the reserve fund for the time being and balance of revenue carried to the balance sheet as on December 31st, 1904.

Mr. BROWN MARTIN seconded, and it was carried unanimously.

An extraordinary general meeting of the company was then held, and the resolutions, as printed in our last issue, were adopted unanimously.

The necessary confirmatory meeting will be held on November 15th.

Monte Video Telephone Co.

THE annual ordinary general meeting of this company was held on Thursday last week, at Winchester House, Old Broad Street.

Mr. F. W. JONES (the Chairman), in moving the adoption of the report and accounts, said that since the re-arrangement of the capital in 1898 the business of the company had steadily increased, and they were now in a very satisfactory position. For the past eight years the whole of the capital expenditure had been met out of revenue, but they had suffered during the Civil War. For several years past the company had been in negotiation with both the Congress of Uruguay and the municipality of. Monte Video, in regard to an extension of their system beyond their present territory, and to connect with Buenos Ayres. They had also contemplated an underground plant in the City of Monte Video, but the consideration of the whole of these things had been delayed by the Civil War, and had progressed but slowly since. The advantages of an underground system had been seen and appreciated by the people and the municipality of the neighbouring city of Buenos Ayres, and they had been met in a liberal manner. It was hoped that before long a similar spirit would prevail in Monte Video. That a connection between the two places was desired was proved by the fact that various banks and other business houses had petitioned for a connection to the system.

The report was adopted.

Electrolytic Alkali Co.

THE report for the year ended August 31st last, states that the net profit for the year, after allowing for depreciation, mortgage debenture interest and expenditure on maintenance of buildings, plant, machinery, tools and all necessary repairs, is £4,746, to which must be added the amount brought forward from last year, namely, £1,374, making a total of £6,120. The directors propose payment on the cumulative preference shares of one year's dividend on account of arrears, at the rate of 7 per cent. per annum on all the preference shares issued prior to April, 1902, and a dividend at the same rate upon all the preference shares issued since that date, calculated, as regards all instalments paid on such shares since August 31st, 1902, from the several dates of payment of such instalments, up to August 31st, 1903. This will absorb £5,601, and leave £519 to be carried forward. The process continues to work satisfactorily, and there is a good demand for the company's products. The great depression which existed in the market price of bleaching powder during the years 1902, 1903 and 1904 has continued, though to a less extent, during the year under review. Towards the close of the year the erection of additional manufacturing plant was continued, and the company is now in a better position for dealing with an increased volume of business.

British Thomson-Houston Co.—The report for the year ended March 31st shows that, after providing for debenture interest, &c., a trading profit of £29,026 remains, which has been applied to various depreciations. The balance of the account for excess cost of manufacturing incident to the establishment of the manufacturing business now stands at £39,261.

Metallic Seamless Tube Co.—As it is thought possible that the paragraph relating to this company's meeting in our last issue, may give the impression that no dividend has been declared, we would remind our readers that, as stated in our issue of October 20th, a dividend of 5 per cent. upon the ordinary shares was recommended by the directors. This was approved by the meeting. The preference dividend of 6 per cent. is, of course, also being paid. The dividend warrants were posted on November 1st.

Struck off the Register.—It is announced that Neild's Sleeve Electric Joint Syndicate, Ltd., has been struck off the register.

Calcutta Electric Supply Corporation.—The number of units delivered to consumers during the five weeks ended September 29th was 546,086, compared with 433,985 in the corresponding five weeks of the preceding year.

St. James' and Pall Mall Electric Light Co.—The amount of electricity sold in the quarter ended Michaelmas, 1905, is returned at 1,375,210 units, estimated to produce £20,055, as against 1,238,880 units, which produced £19,306, for the corresponding period of last year.

Stock Exchange Notices.—Applications have been made to the Committtee to appoint special settling day in—

Johnson & Phillips, Ltd.—6,685 ordinary shares of £1 each, fully paid, Nos. 1 to 6,635; and £116,667 5 per cent. first mortgage debenture stock.

The Committee has further been asked to allow the following securities to be quoted in the Official List :—

Newcastle and District Electric Lighting Co., Ltd.—20,000 shares of £10 each, £9 paid; and 10,000 shares of £10 each, £5 paid.

Oriental Telephone and Electric Co., Ltd.—£100,000 4 per cent. redeemable debenture stock.

City of Buenos Ayres Tramways Co, (1904).—The directors have declared a dividend of 1s. 3d. per share, less tax, for the three months ended September 30th.

Edison & Swan United Electric Light Co.—On Monday, at an extraordinary general meeting, the resolution passed on October 12th for reducing the capital from £941,000 to £888,071 was unanimously confirmed. The resolution granting the directors a further sum of 750 guineas for their services was also agreed to.

Rosario Electric Co.—This company's annual meeting was held on Tuesday, at River Plate House. Mr. W. F. Leese stated that during the twelve months the number of consumers had advanced from 837 to 1,325; and at the end of August they had put on 112 more new consumers, making a total of 1,437. On June 30th, 1904, there were 38 motors, but on June 3rd, 1905, they had 113 motors of 545 H.P.. The business had increased to such an extent that they had no proper reserve of battery power, and the £40,000 additional capital authorised last year had been overspent. The annual report was adopted.

MARKET QUOTATIONS.

Wednesday, November 1st.

CHEMICALS, &c.		Latest Price.	Fortnight's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	32/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal)	per ton	£38 10	..
a ,, ,,	per ton	£30	..
a Bleaching powder	per ton	£5 10	..
a Bisulphide of Carbon	per ton	£15	..
a Borax	per ton	£13	..
a Benzole (90 %)	per gal.	10d.	..
a ,, (50 %)	per gal.	9½d.	..
a Copper Sulphate	per ton	£22 10	50s. inc.
a Lead, Nitrate	per ton	£25	..
a ,, White Sugar	per ton	£31	..
a ,, Peroxide	per ton	£27 10	..
a Methylated Spirit	per gal.	2/6	..
a Naphtha, Solvent (90 % at 160° C)	per gal.	5/6	..
a Potassium Bichromate, in casks	per lb.	8d.	..
a Potash, Caustic (75/80 %)	per ton	£20	..
a Potassium Cyanide	per lb.	7½d.	..
a Shellac	per cwt.	190/-	..
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers	per ton	£6 10	..
a ,, Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %)	per ton	£10 15	..
a ,, Crystals	per ton	£3	..
a Sodium Bichromate, casks	per lb.	2½d.	..
a ,, Cyanide	per lb.	7d.	..
METALS, &c.			
b Aluminium Ingots, in ton lots	per ton	£150	..
b ,, Wire, in ton lots	per ton	£177	..
b ,, Sheet, in ton lots	per ton	£175	..
b Babbitt's metal ingots	per ton	£43 to £140	..
c Brass (rolled metal 2" to 12") basis	per lb.	7⅞d.	..
c ,, Tube (brazed)	per lb.	9½d.	..
c ,, ,, (solid drawn)	per lb.	8½d.	..
c ,, Wire, basis	per lb.	8d.	..
c Copper Tubes (brazed)	per lb.	10⅜d.	..
c ,, ,, (solid drawn)	per lb.	11d.	..
g Copper Bars (best selected)	per ton	£86	£1 inc.
g Copper Sheet	per ton	£86	£1 inc.
g ,, Rod	per ton	£86	£1 inc.
e ,, (Electrolytic) Bars	per ton	£77 10	..
e ,, ,, Sheets	per ton	£90 10	..
e ,, ,, Rod	per ton	£84 10	..
e ,, ,, H.C. Wire	per lb.	9⅜d.	..
f Ebonite Rod	per lb.	3/8	..
f ,, Sheet	per lb.	3/-	..
n German Silver Wire	per lb.	1/6	..
h Gutta-percha, fine	per lb.	6/- to 7/-	..
h India-rubber, Para fine	per lb.	5/1⅔ to 5/2½	dec.
i Iron, Charcoal Sheets	per ton	£18	..
i ,, Pig (Cleveland warrants)	per ton	53/-	1s. 1½d. dec.
i ,, Forgings, according to size	per ton	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	..
i ,, Wire, galvanised No. 8	per ton	£9 15	..
g Lead, English Ingot	per ton	£15 5	..
g ,, ,, Sheet	per ton	£16 17 6	..
m Manganin Wire No. 28	per lb.	8/-	..
g Mercury	per bot.	£7 5	..
d Mica (in original cases) small	per lb.	6d. to 1/-	..
d ,, ,, ,, medium	per lb.	2/6 to 4/-	..
d ,, ,, ,, large	per lb.	4/6 to 8/6	..
p Phosphor Bronze, plain castings	per lb.	1/1 to 1/8	..
p ,, rolled bars & rods	per lb.	1/1½ to 1/8	..
p ,, ,, strip & sheet	per lb.	1/4	..
o Platinum	per oz.	84/-	..
e Silicium Bronze Wire	per lb.	10½d. to 11½d.	..
i Steel, Magnet, acc'd'g to desc'p'n	per ton	£68	..
i ,, ,, in bars	per ton	£15 to £40	..
g Tin, Block	per ton	£150 10 to £151 10	10s. inc.
n ,, Wire, Nos. 1 to 16	per lb.	1/0½	..
p White Anti-friction Metals— "White Ant" brand	per ton	£46 to £70	..
j Yarns, 2/10s Grey Cotton, on sp'le	per lb.	8d.	..
j ,, 6 lea. Flax	per lb.	5⅝d.	..
j ,, 3 ply 10 lbs. Russian	per lb.	4½d.	..
j ,, 10 lbs. Russian, single	per lb.	4⅝d.	..
j ,, 180 lbs. Jute rove	per ton	£11	..
k Zinc, Sh't (Vieille Montagne bnd.)	per ton	£31 15	..

Quotations supplied by:—

a G. Boor & Co.
b The British Aluminium Co., Ltd.
c Thos. Bolton & Sons, Ltd.
d F. Wiggins & Sons.
e Frederick Smith & Co.
f India-Rubber, G.P. and Teleg. Works Co., Ltd.
g James & Shakspeare.
h Edward Till & Co.
i Bolling & Lowe.
j Walter H. Hindley & Co., Ltd.
k Morris Ashby, Ltd.
m W. T. Glover & Co., Ltd.
n P. Ormiston & Sons.
o Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Co., Ltd.

Russian Regulations for Electrical Plants.—The Association for the protection of German electro-technical interests has given a translation of the Russian regulations for the erection, installation, &c., of electrical plants, published by Georg Siemens, Berlin. The regulations begin with general rules as to currents, insulating material, &c., then come rules as to space for electrical machines, and regarding electro-motors, transformers, accumulators, electric lamps, tests, safety appliances, &c. The brochure is recommended to all firms interested in the exportation of electrical goods to Russia.

STOCKS AND SHARES.

Wednesday evening.

CLOSED on November 1st, the Stock Exchange finished October in a mood less depressed than that which ruled a few days earlier. The Russian pressure being sensibly relaxed, prices in all departments rallied after their severe shaking, and the prospect of an immediate, heavy Japanese loan did not prevent substantial improvement in markets as a whole. Electrical sections suffered so little from the semi-slump which seized the House, that the changes this week are comparatively insignificant, although several interesting developments have occurred which demand attention.

At the meetings of the Westminster Electric Supply Corporation held on Tuesday, the proposals for sanctioning an increase in the capital and a decrease in the rate of Preference interest were unanimously carried. In referring last week to the heavy fall which the directors' circular had caused in the price of the shares, we remarked that "shrewd investors will see an excellent opportunity in this slump to acquire cheap stock." Prices of Ordinary and Preference now show a rise of 10s. and 2s. 6d. respectively. The effect of the little scare has not entirely passed off even yet. Charing Cross 1903 Preference are ⅛ lower, and Urban Ordinary fell a similar fraction to 4⅝. City of London Ordinary are ⅜ down, at 12⅜, after their recent advance in consequence of the working agreement between the City and the Charing Cross Companies. Allowing for the deducted dividend, Edmundson's Preference are a trifle harder at 6$\frac{4}{32}$. Calcutta Electric new shares command 32s. 6d. premium, so the blandishments of the person who is trying to buy them at 5s. premium can be treated in the manner which such impudent attempts deserve.

Railway stocks were about the firmest of any in the Stock Exchange during the period of acute weakness already mentioned. The improvement in business is directing attention to the stocks of the "trade" lines, and others which move in sympathy are naturally better. Metropolitans put on ½, at 92, but Districts eased off to 38, despite the near approach of steam's complete abolition from the company's trains. City and South London continues to make headway, having a point rise to its credit, upon the turning of speculative interest to low-priced dividend-paying stocks. Central Londons are nominally unchanged, but the market is short of the Ordinary stock, and the real price is 92¼ to 93. Waterloo and City soon lost its rise of 2 per cent.

Reference to the extended list of traction issues, given overleaf, will show that this section is very quiet. There is $\frac{1}{16}$ loss in Anglo-Argentine Ordinary, and British Columbia Railway Ordinary, *ex* 3 per cent. dividend, is this amount down. We are informed that a fresh scheme is afoot in regard to the Buenos Ayres Grand National Tramways Co., and the first Preference shares are good at nearly 7. Belgrano "A" Preference put on ⅛ to 5⅞. A good deal of quiet business is being done in several out-of-the-way electric traction and lighting concerns. Rio de Janeiro, Sao Paulo, Mexican and other companies dealing with electricity in one form or another find little difficulty in placing very substantial blocks of bonds with capitalist undertakings (such as insurance companies) on this side. Most of the transactions do not go through Stock Exchange channels at all: the bargains are transacted by agents who have the placing of the stock, but if approximate quotations should be required, they can be obtained as a rule. The 5 per cent. bonds of the Electrical Development of Ontario Co.—one of the undertakings that harnesses Niagara—stand about 95, which gives a rough idea of the value of such securities.

Coming home again, it is not, perhaps, breaking confidence to say that when fresh capital was required the other day for the Mansfield electric tramways, the money was subscribed, quickly and privately, by an issue of 4½ per cent. Debenture stock at 98.

Most of the changes amongst Telegraphs are due to *ex* dividend markings. The shock to general speculation has left Anglo "A" with a fall of ⅝ to 15¾, and the Preferred receded another 10s. to 108. Cuba Ordinary and Preference show the dividend deductions, and so do Globe shares of both sorts. Direct United States continue to advance on the excellent report, and have gained 5s. more at 13¼. Marconi shares are $1\frac{7}{16}$. The company, it may be recalled, has an authorised capital of half a million sterling in £1 shares, of which rather more than half are issued and fully-paid. Telephone descriptions display no alteration of any consequence.

Manufacturing varieties hold their prices extremely well. Callender's Ordinary have regained their 5s. dividend, and there is a small rise to 20s. in Castner-Kellner Alkali. At length there is a movement in Willans & Robinson, the Debenture stock at 79½ showing a rise of 3 points.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last four years. 1902.	1903.	1904.	1905.§	Closing Quotations Oct. 25th.	Closing Quotations Nov. 1st.	Business done week ended Nov. 1st, 1905. Highest	Lowest.	Rise + or Fall —
34,800	African Direct Telegraph, 4 % Debs...	100	4 %	4 %	4 %	..	99 —102	99—102	..	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	..	3 — 3½	3¼— 3⅝	3⅜	3¼	+ ¼
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	Nil	Nil	Nil	..	82 — 87	82 — 87	83	82	..
768,580	Anglo-American Telegraph	Stock	60/6	61s.	2½%	29s.§	60 — 62	60 — 62	..	..	..
3,118,210	Do. do. do. 6 % Pref.	Stock	6 %	6 %	5½%	58s.§	108 —109	107½—108½	108⅜	107½	..
3,118,210	Do. do. do. Deferred	Stock	1/-	2s.	Nil	..	16½— 16¾	15⅝— 15⅞	16¼	15 11/16	..
44,000	Chili Telephone, Nos. 1 to 44,000	5	6 %	7 %	8 %	..	7½ — 7⅞	7¼ — 7⅝	..	..	..
1,932.856£	Commercial Cable Stng. 500 year 4 % Deb. Sk. Red.	Stock	4 %	4 %	4 %	..	97 — 99	97 — 99	97⅜	97¼	..
16,000	Cuba Telegraph	10	6½%	10 %	5 %	5 %§	9 — 9½	8¾— 9⅛xd	..	..	..
6,000	Do. 10 % Pref.	10	10 %	5 %	10 %	10 %§	17½— 18½	17 — 18 xd	..	..	..
12,931	Direct Spanish Telegraph, Ord.	5	4 %	4 %	4 %	4 %§	3⅜— 3⅝	3⅜— 3⅝	..	..	..
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 %§	9¼— 9⅝	9¼— 9⅝	..	..	..
30,000	Do. do. 4½ % Debs.	50	4½%	4½%	4½%	4½%§	100 —103 %	100 —103	..	..	..
60,710£	Direct United States Cable	20	3½%	3 %	3½%	3 %§	12⅜— 13¼	13 — 13½	13½	13	+ ¼
74,500	Direct W. India Cable, 4½ % Reg. Deb., 1 to 1,200,R.	100	4½%	4½%	4½%	..	100 —102	100 —102	..	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	5 %§	143 —146	143 —146	145⅝	145	..
2,000,000	Do. 3½ % Pref. Stock	100	3½%	3½%	3½%	3½%§	89 — 91	89 — 91	89	..	..
1,836,814	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	4 %§	108 —110	106 —108 xd	107⅞	..	..
300,000	Eastern Extension, Australiasia, and China Tele.	10	7 %	7 %	7 %	6 %§	14¼— 14⅝	14¼ — 14⅝	14⅝	14 7/16	..
602,400	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %§	106 —108	106 —108	..	..	..
300,000	East & S. Afric. Tel., 4 % Mt. Db., 1 to 8,000, red. 1909	100	4 %	4 %	4 %	..	99½—101½	99½—101½	..	..	..
c. 200,000£	Do. 4 % Reg. M. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	..	101½—103½%	101½—103½	..	..	..
180,887	Globe Telegraph and Trust	10	£3	5½%	5⅝%	..	10⅝— 11	10⅝— 10¾xd	10 11/16	10⅝	..
180,887	Do. do. 6 % Pref.	10	6 %	6 %	6 %	..	14½— 14⅝	14¼— 14½xd	14½	14½	..
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	15 %	24 %	..	35½— 36½	35½— 36½	..	..	..
46,500	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	4½%	4½%	4½%	..	100 —102	100 —102	..	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	13 %	..	55 — 57	54½— 56½xd	..	..	..
72,680	Monte Video Telephone Co., Ltd. Ord.	1	3 %	3 %	4 %	..	⅞— 1	1/16— 1 1/16xd	1 1/16	..	..
1,983,333	National Telephone, Pref. Stock	100	6 %	6 %	6 %	6 %§	112 —113	112 —113	112⅝	112⅜	..
1,966,667	Do. do. Def. Stock	100	4½%	5 %	5 %	5 %§	107 —108	107 —108	107⅝	107½	..
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	6 %§	13 — 15	13 — 15	14½	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	6 %§	12 — 13	12 — 13	..	..	..
250,000	Do. do. 5 % Non-cum. 3rd P., 1 to 250,000	5	5 %	5 %	5 %	5 %§	5⅜— 5⅝	5⅜— 5⅝	5⅝	5 21/32	..
2,000,000	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	..	98 —100	97 — 99	98½	98	—1
1,689,593	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	..	104 —106	104 —106	104½	..	..
179,313	Oriental Telep. and Elec. 1 to 171,504, fully paid	1	6 %	6½%	6½%	6 %	1⅛— 1⅜	1⅛— 1⅜xd	..	..	..
50,000	Do. do. do. 6 % Cum. Pref.	1	6 %	6 %	6 %	6 %	1 3/16— 1 5/16	1 3/16— 1 5/16xd	..	..	..
100,000	Pacific & European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	..	100 —103	100 —103	..	..	..
11,839£	Reuter's	8	5 %	5 %	5 %	5 %§	7⅞— 8¼	7⅞— 8¼	..	..	..
3,287	Submarine Cables Trust	Cert.	6 %	6 %	6 %	..	125 —128	125—128 xd	..	..	..
58,000	United River Plate Telephone	5	7 %	8 %	8 %	..	7 — 7⅛	7 — 7⅛	..	..	..
40,000	Do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	5 %	5 %	..	5¼— 5⅜	5¼— 5⅜	..	..	..
179,947	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	..	110 —112	110 —112	..	..	..
15,609£	West African Telegraph, Shares	10	2 %	4 %	4½%	4 %	10 — 10½	10 — 10¾	..	..	..
30,008	W. Coast of America, 1 to 30,000 & 53,001 to 53,008	2½	Nil	Nil	Nil	..	9/16— 11/16	9/16— 11/16	..	..	..
150,000	Do. 4 % Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	4 %	4 %	4 %	..	100 —102	100 —102	..	..	..
207,930	Western Telegraph, Ltd., Nos. 1 to 207,930	10	7 %	7 %	7 %	..	14¼— 14⅝	14¼— 14⅝	14½	14 5/16	..
75,000	Do. do. 5 % Debs. 2nd series, 1906	100	5 %	5 %	5 %	..	101 —103	101 —103	..	..	..
563,380	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	..	102¼—104½	102¼—104½	..	..	..
88,321	West India and Panama Telegraph	10	Nil	Nil	Nil	..	1/16— 1/8	1/16— 1/8	..	..	..
34,563	Do. do. 6 % Cum. 1st Pref.	10	7 %	7 %	6 %	..	8¼— 9	8¼— 9	..	..	..
4,669	Do. do. 6 % Cum. 2nd Pref.	10	Nil	Nil	Nil	..	7⅛— 8	7⅛— 8	..	..	..
80,000£	Do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	5 %	..	101 —104	101 —104	..	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

850,000	Anglo-Argentine Trams, 260,008 to 430,007	5	..	..	8 %	6 %§	8 11/16— 8 13/16	8⅝— 8⅞	8 13/16	8 11/16	— 1/16
1,300,035	Do. 5½ % Cum. Prefs., 1 to 260,007	5	..	5 %	5 %	5½%	5⅞— 6⅛	5⅞— 6⅛	6 1/16	5 29/32	..
266,600	Do. Permanent, 6 % Deb. Stock, 1888	100	..	6 %	6 %	6 %	141 —144	141 —144	..	..	..
200,000	Auckland E. Trams., 5 % 1st Mort. Deb. Stock	100	..	5 %	5 %	5 %	104 —106	105 —107	106	..	+1
530,000	Babcock & Wilcox, 1 to 530,000	1	..	17 %	20 %	16 %‖	3⅜— 4	3⅜— 4	3 15/16	3 27/32	..
100,000	Do. do. 6 % Cum. Pref., 1 to 100,000	1	..	6 %	6 %	6 %	1 7/16— 1 9/16	1 7/16— 1 9/16	..	..	..
40,000	British Aluminium 7 % Cum. Pref.	5	Nil	Nil	Nil	..	5— 5⅛	5— 5⅛	..	..	..
20,000	Do. do. "A" 6 % Cum. Pref.	5	Nil	Nil	Nil	..	4⅜— 5¼	4⅜— 5¼	..	..	..
20,000	Do. do. 4 % Funding Certs.	5	..	..	..	..	2¾— 3¼	2¾— 3¼	..	..	..
300,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	5 %	5 %	5 %	..	100 —104	98 —102 xd	..	..	..
300,000	British Columbia E. Rail Def. Ord. Stock	100	..	6 %	6 %	..	126 —129	123 —126 xd	126	125½	..
300,000	Do. 5 % Pref. Ord. Stock	100	..	5 %	5 %	..	109 —112	110 —113	..	..	+1
115,000	Do. 5 % Cum. Perp. Pref. Stock	100	..	5 %	5 %	5 %	105 —108	106 —109	..	..	+1
240,400	Do. 4½ % 1st Mort. Debs., 1 to 6,250	40	..	4½%	4½%	4½%	103 —105%	103 —105	103⅛	..	..
220,000	Do. 4½ % Vancouver Power Debs., 1 to 2,200	100	..	4½%	4½%	4½%	100 —103	101 —104	..	..	+1
133,301	British Electric Traction	10	8 %	6 %	6 %	..	9⅜— 10⅛	9⅜— 10⅛	10	9⅞	..
156,437	Do. do. 6 % Cum. Pref.	10	6 %	6 %	6 %	..	11 — 11⅛	11 — 11⅛	11 5/16	11 1/16	..
1,000,000£	Do. do. 5 % Perp. Deb. Stock	Stock	5 %	5 %	5 %	..	121 —123	121 —123	122½	..	..
250,000	Do. do. 4½ % 2nd Deb. Stock Red.	100	..	..	4½%	..	99 —101	97 — 99 xd	101	..	..
100,000	British Insulated and Helsby Cables	5	10 %	8 %	8 %	8 %§	6⅞— 7⅛	6⅞— 7⅛	6 31/32	..	..
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	6 %§	5⅝— 6⅛	5⅝— 6⅛	..	..	..
500,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	4½%	4½%	4½%	4½%§	103 —106	103 —106	105½	..	..
212,000	British Thomson-Houston 4½ % 1st Mort. Debs.	100	..	4½%	4½%	4½%	98 —100	98 —100	..	..	..
2,000,000	British Westinghouse 6 % Pref., 1 to 200,000 and 275,001 to 475,000	5	..	6 %	Nil	..	2⅜— 2⅝	2⅜— 2⅝	2⅜	..	..
1,016,353	Do. do. 4 % Mort. Deb. Stock	100	..	4 %	4 %	4 %	85 — 89	85 — 89	..	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	Nil	Nil	..	1/16— 1/8	1/16— 1/8	..	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	Nil	Nil	Nil	..	14/6 to 15/6	14/6 to 15/6	..	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	Nil	Nil	Nil	..	¼— ⅜	¼— ⅜	..	..	..
150,000	Do. Non-cum. 6 % Pref.	2	6 %	6 %	6 %	..	1¼— 1⅜	1¼— 1⅜	..	..	..
125,000£	Do. 4½ % Perp. Deb. Stock	Stock	4½%	4½%	4½%	..	93 — 97	93 — 97	96⅜	..	..
125,000£	Do. 4½ % Perp. 2nd Deb. Stock	Stock	4½%	4½%	4½%	..	78 — 81	78 — 81	..	..	..
500,000	Buenos Ayres & Belgrano, 1 to 100,000	5	..	3 %	4 %	..	3 1/16— 3 1/8	3 1/16— 3 1/8	3 1/8	3⅛	..
200,000	Do. "A" 6 % Cum. Pref., 1 to 40,000	5	..	6 %	6 %	..	5 1/16— 5 1/8xd	5 1/16— 5 1/8	5 1/8	5 1/16	+ 1/16
137,500	Do. "B" do. 1 to 27,500	5	..	6 %	6 %	..	5— 5⅛ xd	5— 5⅛	5 3/16	..	..
317,700	Do. 5 % Deb. Stock	100	..	5 %	5 %	5 %	106 —108	106 —108	105	..	..
190,000	Do. 5 % 2nd Deb. Stock	100	..	5 %	5 %	5 %	102 —105	102 —105	104¼	103⅝	..
525,000	Calcutta Trams., 1 to 105,000	5	..	6 %	8 %	7 %§	9 — 9¼	9 — 9¼	9 1/16	..	..
163,050	Do. 105,001to 137,610	5	..	..	..	3d.	8¾— 9	8¾— 9	..	..	..
350,000	Do. 4½ % 1st Deb. Stock	100	..	4½%	4 %	4½%	107 —109	107 —109	..	..	..
35,000	Callender's Cable Construction shares	5	15 %	12½%	12½%	10%	11 — 12	11 — 12 xd	11 1/16	11 1/16	..
40,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	5⅝— 5⅞	5⅝— 5⅞	..	..	..
300,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	109 —111	109 —111	..	..	..
491,222	Cape E. Trams., 1 to 491,222	1	..	15 %	10 %	5 %§	1 — 1⅛	1 — 1⅛	..	..	..
450,000	Castner-Kellner Alkali, 1 to 450,000	1	..	4 %	4 %	..	⅞— 1	20/- — 21/-	..	..	+1/3
230,211	Do. do. 4½ % 1st Mort. Deb. Stock	100	..	4½%	4½%	4½%	97 —102	97 —102	99	..	..
1,963,208	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	4 %§	91 — 93	91 — 93	92¼	91⅛	..
523,396	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	4 %§	101 —103	101 —103	..	..	..
523,396	Do. do. Def. do.	Stock	4 %	4 %	4 %	..	83 — 86	83 — 86	..	..	..
1,330,000	City and South London Railway	Stock	3½%	2⅞%	2½%	2 %§	42 — 44	43 — 45	44⅞	43	+1
85,000	Crompton & Co., Nos. 1 to 85,000	3	5 %	2½%	2½%	..	1⅜— 1⅝	1⅜— 1⅝	1 9/16	..	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	..	5 %	5 %	5 %	..	94 — 99	94 — 99	..	..	..

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § Interim dividends.
‖ And bonus of 10s. ¶ From Manchester Share List.

(Continued on next page.)

SHARE LIST OF ELECTRICAL COMPANIES.—*(Continued).*

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.—*(continued).*

Present Issue.	NAME.	Stock or Share.	Dividends for the last four years.				Closing Quotations Oct. 25th.	Closing Quotations Nov. 1st.	Business done week ended Nov. 1st, 1905.		Rise + or Fall—
		†	1902.	1903.	1904.	§1905.			Highest	Lowest.	
260,000	Dick, Kerr & Co., 1 to 52,000	5	..	..	10 %	..	8¼ — 9	8½ — 9	8⅝	..	..
305,000	Do. do. 6 % Cum. Pref., 1 to 61,000	5	..	6 %	6 %	6 %	6 — 6¼	6 — 6¼	..	..	..
294,150	Do. do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	106 —108	106 —108	..	..	..
600,000	Dublin United Trams. (1896), 1 to 60,000	10	..	5½%	6 %	3 %	13¼ — 14½	13¼ — 14½	..	..	..
599,700	Do. 6 % Pref. between 1 and 60,000	10	..	6 %	6 %	6 %	15 — 16	15 — 16	..	..	..
63,400	Do. 4 % Debs.	100	..	4 %	4 %	..	99 —101	99¼—100½	..	..	..
300,000	Do. 3½ % "A" Debs.	100	..	3½%	3½%	..	97 — 99	98 — 99	..	..	+ ⅛
300,000	Do. 3½ % "B" Deb. Stock	100	..	3½%	3½%	..	97 — 99	97⅞	..	..	..
99,261	Edison & Swan Utd., "A" shrs., £3 pd., 1 to 99,261	5	Nil	Nil	2½%§	..	1⅝ — 1⅞	1⅝ — 1⅞	1⅝	..	..
17,139	Do. "A" shares, 01—017,139	5	Nil	Nil	2½%§	..	2 — 2½	2 — 2½	..	..	..
344,023£	Do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	..	85 — 90	85 — 90	..	..	..
100,000£	Do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	5 %	5 %	5 %	..	92 — 97	92 — 97	..	..	..
112,100	Electric Construction 1 to 112,100	2	6 %	4 %	Nil	..	⅝ — ¾	⅝ — ¾	..	..	..
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2	7 %	7 %	7 %	..	1¼ — 2⅜	1¼ — 2⅜	..	..	..
200,000	Do. do. 4 % Perp. 1st Mort. Deb. Sk.	Stock	4 %	4 %	4 %	..	92 — 95	92 — 95	..	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	..	9⅜ — 10	9½ — 10	..	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	4 %	4 %	4 %	..	96 —100	96 —100	..	..	..
780,000	Gt. N. & City Rail Pref. Ord. "A" 4 % 1 to 78,000	10	..	3 %	4 %	4 %§	5 — 5⅛	5 — 5⅛	..	..	..
96,000	Greenwood & Batley 7 % Cum. Pref.	10	..	7 %	7 %	7 %	10⅜— 11	10½— 11	..	..	— ⅛
80,000	Do. do. 5 % Mort. Debs.	100	..	5 %	5 %	5 %	99½—100½	99½—100½	..	..	..
200,000	Henley's (W. T.), Telegraph Works, Ord.	5	20 %	15 %	15 %	10%§	12 — 13	12 — 13	12⅜	12¼	..
200,000	Do. do. 4½ % Pref.	5	4½%	4½%	4½%	..	5⅛ — 5⅜	5⅛ — 5⅜	5⅛	..	..
45,900	Do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	..	109 —111	109 —111	..	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works.	10	10 %	10 %	5 %	2½%§	15⅛ — 16½	15⅛ — 16½	16⅛	16	..
300,000£	Do. do. 4% 1st Mort. Deb.	100	4 %	4 %	4 %	..	99 —102	99 —102	..	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	1⅜%	1½%	..	2⅛ — 2⅜	2⅛ — 2⅜	..	..	..
10,000	† Do. do. Pref. £10 paid	10	5 %	5 %	5 %	5 %	9 — 9½	9 — 9½	..	..	..
600,070	London United Trams (1901), 1 to 50,007	10	..	8 %	6 %	4 %§	10 — 11	10 — 11	..	..	..
399,930	Do. do. 60,008 to 100,000 (£4 paid)	10	..	8 %	6 %	4 %§	4 — 5	4 — 5	..	..	..
1,125,000	Do. do. 5 % Cum. Pref., 1 to 125,000	10	..	5 %	5 %	5 %	9⅜ — 10½	9⅜ — 10½	10⅛	..	..
1,331,000	Do. do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	100 —103	100 —103	102	..	..
160,000	Peebles (B.) & Co. 6 % Cum. Pref., 20,001 to 40,000	5	..	..	6 %	6 %	4⅞ — 5⅛	4⅞ — 5⅛	..	..	..
240,500	Potteries E. Trc., 20,001 to 40,000 & 50,001 to 54,500	10	..	5 %	5 %	..	8½ — 9½	8½ — 9½	..	..	..
240,500	Do. 5 % Cum. Pref., 1 to 20,000 & 40,001 to 44,500	10	..	5 %	5 %	5 %	9¼ — 9¾	9 — 9¾	..	..	— ¼
245,000	Do. 4½ % Deb. Stock	100	..	4½%	4½%	..	102 —105	101 —104	..	..	—1
37,350	Telegraph Construction and Maintenance	12	20 %	20 %	15 %	..	33½ — 35½	33½ — 35½	34	33⅜	..
150,000£	Do. 4 % Deb. Bds., 1 to 1,500 Red. 1909	100	4 %	4 %	4 %	..	102 —104	102 —104	..	..	..
3,599,200	Undergd. E. R., Lon., 5 % Profit Shar. S. Nts.	..	..	..	5 %	5 %	99½—100½	99½—100½	..	..	..
540,000	Waterloo & City Railway, Ord. Stock	100	3½%	3½%	3½%	3 %§	90 — 92	88 — 90	88	..	—2
333,330	Willans & Robinson, 1 to 30,000 & 80,001 to 116,666	5	..	6 %§	..	..	1¼ — 2	1¼ — 2	1⅛	1⅛	..
333,330	Do. 6 % C. P., 30,001 to 80,000 & 125,001 to 141,666	5	..	3 %	..	..	2⅛ — 3¼	2¼ — 3¼	..	..	..
246,806	Do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	..	74 — 79	77 — 82	81	..	+3

ELECTRICITY SUPPLY COMPANIES.

70,000	Bromley (Kent) E.L. & P., 1 to 14,000	5	..	5 %	5⅛%	4 %§	5⅛— 5⅜	5⅛— 5⅜	..	..	..
50,000	Do. do. 4½ % 1st. deb. stock	100	..	4½%	4½%	4½%	104 —107	102 —105 xd	..	..	..
29,377	Brompton & Kens. Elec. Lt. Sup., Ord., 1 to 20,000	5	8 %	10 %	10 %	..	9⅜ — 10¼	9⅜ — 10¼	..	..	— ⅛
29 623	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	..	9¼ — 9⅜	9¼ — 9⅜	9⅜	..	..
10'782	Central Electric Supply 4 % Guar. Deb. Stock	100	4 %	4 %	4 %	..	105 —108	105 —108	..	..	..
80,000	Charing Cross and Strand Electricity Supply	5	10 %	8 %	8 %	5 %§	7⅛ — 8	7⅛ — 8	7⅛	7⅛	..
80,000	Do. do. 4½ % Cum. Pref.	5	4½%	4½%	4½%	..	5¼ — 5⅝	5¼ — 5⅝	5⅜	..	..
40,000	Do. "City Undertaking" 4½ % Cum. Prf.	5	4½%	4½%	4½%	..	4⅜ — 5	4⅜ — 5	..	..	— ⅛
40,000	Do. do. 1903	5	..	4½%	4½%	..	4⅜ — 5⅛	4⅜ — 5	..	..	..
350,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	..	103 —105	103 —105	..	..	..
44,436	Chelsea Electricity Supply, Ord.	5	4½%	5½%	6 %	4½%§	5⅝— 6¼	5⅝— 6¼	..	..	..
150,000£	Do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%§	110 —112	110 —112	..	..	..
70,595	City of London Elec. Lighting, Ord. 40,001—110,595	10	5 %	5 %	6 %	..	12½ — 13	12¼ — 12⅝	12⅛	12⅜	— ⅜
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	..	13¼ — 14¼	13¼ — 14¼	13⅝	13⅛	..
400,000£	Do. 5 % Db. Stk., Scrip. (iss. at 115) all pd.	..	5 %	5 %	5 %	..	124 —128	124 —128	..	..	..
300,000	Do. 4½ % 2nd Db. Stk., Prov. Crts., all pd.	100	4½%	4½%	4½%	..	104 —106	104 —106	..	..	..
40,000	County of London Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4½%	4 %§	9⅜ — 10¼	9⅜ — 10¼	10⅛	..	..
30,000	Do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	..	12⅜ — 12¾	12⅜ — 12¾	12⅝	..	..
400,000£	Do. do. 4½ % Deb. Stock	..	4½%	4½%	4½%	..	111 —114	111 —114	..	..	..
250,000	Do. do. 4½ % 2nd Deb. Stock	Stock	4½%	4½%	4½%	..	104 —106	102 —104 xd	..	..	..
70,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	7 %	..	5¼ — 6	5¼ — 6	5⅝	..	..
80,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	..	6⅝ — 6⅞	6⅛ — 6⅜ xd	..	..	..
300,000£	Do. do. 4½ % 1st Mort Deb. Stk	100	4½%	4½%	4½%	..	109 —111	109 —111	..	..	..
50,000	Folkestone, 1 to 10,000	5	..	5½%	5½%	4 %§	5¼— 5⅜	5¼— 5⅜	5¼	..	..
50,000	Do. 5 % Cum. Pref., 1 to 10,000	5	..	..	..	5 %	5 — 5⅛	5 — 5⅛	..	..	..
50,000	Do. 4½ % 1st. Deb. Stock	100	..	4½%	4½%	4½%	100 —103	100 —103	..	..	..
65,000	Hove, 1 to 13,000	5	..	8½%	8½%	..	8 — 8¼	8¼— 8⅝	8½	..	+ ⅛
10,000	Do. New (£5 10s. paid)	£3	..	8½%	8½%	..	5⅜— 6¼	5⅜— 6¼	..	..	..
37,300	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	95 — 98	95 — 98	..	..	..
7,300	Do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	95 — 98	98 —102	..	..	+3½
21,000	Kensington and Knightsbridge Electric Ord.	5	10 %	12½	12½	..	12 — 12⅝	12 — 12⅝	12⅛	..	..
136,000	Do. do. do. 4 % Deben. Stk.	Stock	4 %	4 %	4 %	..	98 —101	98 —101	..	..	..
111,000	London Electric Supply Corporation, Limited, Ord.	3	Nil	Nil	3 %	..	1⅜— 2⅛	1⅜— 2⅛	..	..	..
60,000	Do. do. do. 6 % Pref.	5	6 %	6 %	6 %	..	5⅛— 5⅝	5⅛— 5⅝	..	..	..
371,895	Do. do. 4 % 1st Mort. Deb. Stk. Red.	Stock	4 %	4 %	4 %	..	99 —102	99 —102	..	..	..
100,000	Metropolitan Electric Supply, 1 to 100,000	5	7½%	8½%	10 %	10%§	10 — 10½	10 — 10½	10⅛	1⅜	..
76,121	Do. 4½ % Cum. Pref. 1—71,106, £3 pd.	5	4½%	4½%	4½%	..	5⅝— 5⅞	5⅝— 5⅞	..	..	..
220,000£	Do. 4½ % 1st Mort. Deben. Stock	..	4½%	4½%	4½%	..	109 —113	109 —113	..	..	..
250,000£	Do. 3½ % Mort. Deben. Stock Redem.	Stock	3½%	3½%	3½%	..	98 —100	98 —100	..	..	..
250,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	100	4½%	4½%	4½%	..	102 —104	101 —103	102	..	—1
285,045	Newcastle-on-Tyne, 1 to 57,009	5	..	8 %	8 %	2½%§	8 — 8¼	8 — 8¼	..	..	..
89,255	Do. 57,010 to 75,000	5	..	..	..	2½§	8 — 8¼	8 — 8¼	..	..	..
285,045	Do. 5 % Pref., 1 to 57,009	5	..	5%	5	5 %	6¼ — 6⅜	6¼ — 6⅜	..	..	..
89,955	Do. 57,010 to 75,000	5	..	..	..	2½§	6¼ — 6⅜	6¼ — 6⅜	..	..	..
10,852	Notting Hill Electric Lighting	10	6 %	6 %	7 %	..	14 — 15	14 — 15	..	..	..
59,000	Do. do. 4 % 1st Mort. Deb.	100	4 %	4 %	4 %	..	98 —100	98 —100	..	..	..
92,500	Oxford, 1 to 96 and 407 to 18,810	5	..	6½%	7 %	5 %§	6⅜— 6⅞	6⅜— 6⅞	6⅜	..	..
50,000	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	100 —102	100 —102	..	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	11½%	11½%	11½%	10%§	14 — 15	14 — 15	..	..	..
20,000	Do. do. 7 % Pref. 20,081 to 40,080	5	7 %	7 %	7 %	7 %§	8½— 9⅛	8½— 9⅛	..	..	..
150,000£	Do. do. 3½ % Deb. Stock Red.	100	3½%	3½%	3½%	..	98 —100	98 —100	..	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	2½%	4 %	4 %	..	2 — 2¼	2 — 2¼	..	..	..
50,000	Do. do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	..	76 — 80	76 — 80	..	..	..
65,000	South London Electricity Supply, Ord.	5	1½%	3 %	4 %	..	3½— 4	3½— 4	3¹³/₁₆	..	..
100,000	South Met. Elec. Lt. & Power (Ord.	1	Nil	Nil	Nil	..	⅛— ¼	⅛— ¼	..	..	..
50,000	*(Late Blackheath and Greenwich* 7 % Pref.	1	Nil	7 %	7 %	..	1⅝— 1⅞	1⅝— 1⅞	1⅝	..	..
100,000	*Dist. E.L.Co.)* 4½ % 1st Deb. Stk.	100	4½%	4½%	4½%	..	105 —108	105 —108	..	..	..
30,000	Urban Electric Supply, Ord.	5	5 %	5 %	5 %	..	4⅝— 4¾	4⅝— 4⅝	4⅝	..	— ⅛
90,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	..	5 — 5¼	5 — 5¼	..	..	..
200,000	Do. do. 4½ % 1st Mort. Db. Stk. Red	100	..	..	4½%	..	103 —105	103 —105	..	..	..
110,000	Westminster Electric Supply, Ord.	5	12 %	13½%	14 %	13%§	11⅜— 12¼	12¼— 12⅝	12¼	12⅜	+ ⅛
26,151	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	..	5⅝— 6⅜	6 — 6½	6⅛	..	+ ⅛

Shares not officially quoted :—Mackay Companies, ord., 47—48. Pref. 74½—75½.

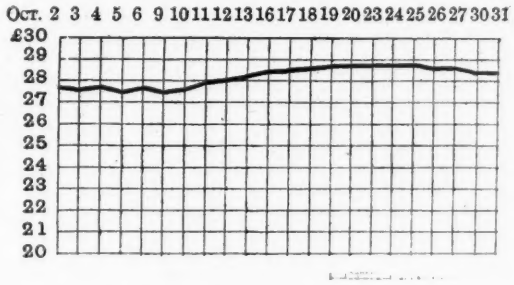
† Unless otherwise stated all shares are fully paid. § Interim dividends.

Bank rate of discount 4 per cent. (September 28th, 1905).

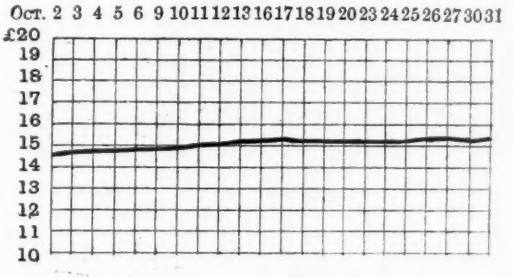
METAL MARKET.

Fluctuations in October.

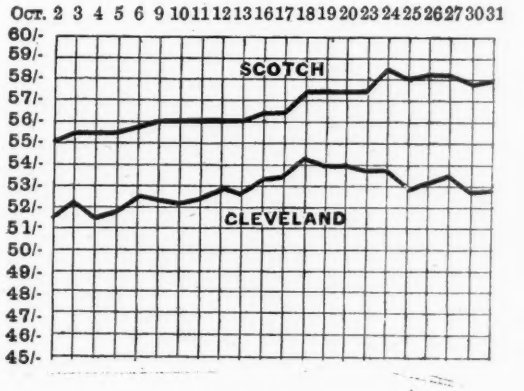
SPELTER (G.O.B's.)



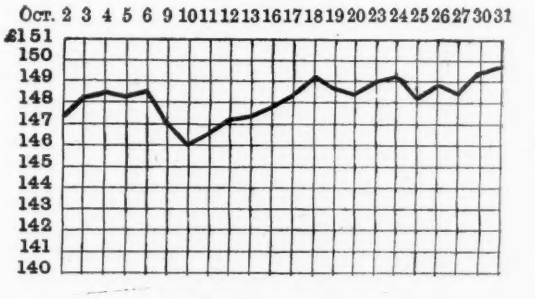
LEAD (ENGLISH)



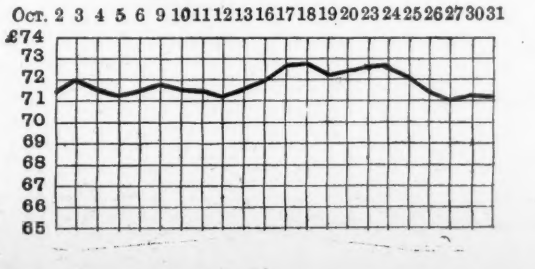
IRON.



TIN.



COPPER (G.M.B's.)



ELECTRICITY v. GAS FOR MOTIVE POWER.

We are daily receiving fresh evidence that the lessons of Olympia are making themselves felt, and, perhaps, the surest sign of all is the great amount of trouble being taken just now by our gas contemporaries to prove the superiority over electricity of the commodity in which they are interested, for such purposes as lighting, heat and power.

A paper has recently been started called *Gas and Oil Power*, which publishes several pages of tables purporting to show the advantage of a private suction gas plant over a public supply of either gas or electricity for power purposes.

We have seen figures which appear to prove conclusively the relative cheapness of various other sources of power as compared with electricity and other agents, and at first sight such figures appear to be very convincing.

The curious part of the whole business is that, in spite of such statements, hard-headed business men throughout the three kingdoms are almost daily equipping new factories with electric motors, or replacing their existing plant, and going in wholesale for electric driving. Hence we are driven to inquire wherein lies the fallacy of these wonderful statements.

Our esteemed contemporary, the *Gas World*, seeing that the tables in question are turned against town gas to the advantage of the suction gas plant, suggests a very obvious flaw in the figures given by *Gas and Oil Power*.

The new publication in question gives the relative costs of power per B.H.P. per hour, with public supplies of electricity and gas, and with a private suction gas plant. The cost with gas is given as anything from a quarter to half that of electricity—at that the *Gas World* makes no complaint—and the cost with suction gas as from one-tenth to one-twentieth of the figures for electric motors.

Now, if such figures truly represent the actual state of affairs, it seems incredible that managers of factories and other users of power should have anything else installed but the particular plant that the tables are intended to advertise.

At the foot of the tables the following note appears :—"The figures for the electricity and gas supply have been respectively taken, by permission, from Garcke's 'Manual of Electrical Undertakings,' and 'The *Gas World* Year Book.' The prices of coal at the various towns are special quotations for a first class coal. The cost per B.H.P. and per B.T.U. do not in any case include permanent charges, as it is impossible to estimate these on hypothetical cases." The *Gas World* takes exception to the somewhat ambiguous term, "permanent charges," and asks if it refers to capital charges. If so, it argues very truly that if such charges are excluded under the head of suction gas, the cost resolves itself into the mere charge for fuel, which, of course, is no criterion whatever of the relative cost of the three systems.

It certainly does not interest a prospective consumer, who wants to know how much it will cost him to run a certain electric motor, if you tell him the coal costs of the generating station from which you hope to give him a supply.

To bring the figures to the same basis for the purpose of *a purely academic comparison*, it is necessary to include all costs; and capital charges being very heavy in the suction gas system, will put a very different complexion on the matter.

The capital cost of engines for use on a public supply of gas, is also very considerably higher than is the case with electric motors.

But, as we have said, such comparisons are purely academic, for other considerations come into the question when viewed from a practical standpoint, which, with a reasonable price per B.T.U. for electricity, put electric driving far ahead of its rivals.

One of the most important of these is the great adaptability of electric motors to sub-division into small units, thus doing away with the light load losses inseparable from a large engine, and with the enormous waste from the labyrinth of belts and countershafting which one sees in factories driven from one source of power. So great is the waste under these heads that many factories, formerly driven by large gas engines direct, have found it far more economical to use their engines to drive dynamos, and re-

convert the current into mechanical energy by motors, than to drive direct by means of shafting and belts.

In the case of a large factory where a number of machines of all sizes are installed, it has been proved over and over again by experience that electric driving by small units is by far the most economical as well as the most convenient system to adopt.

As to whether the main supply of electricity can be generated more cheaply on the premises than it can be obtained from the public supply mains, is a point which depends entirely on local conditions. It depends, for instance, on the terms obtainable by large users from the supply authority, and on the system it is proposed to adopt if a private plant is decided upon. In the case of the latter alternative the rival merits of various systems of generation have to be considered. There are people who are convinced that nothing is cheaper than steam, and there are others who can bring pages of figures to show that Dowson gas, for instance, is by far the most economical.

From what we have seen in *Gas and Oil Power*, we are prepared to find others who will tell us that the proper source of power is a suction gas installation.

Now, in weighing the merits of all such rivals, one has to consider not merely the fuel costs in each case, but also such items as interest on capital, depreciation and repairs, and also attendance. Such being the case, it appears to us to be extremely misleading, to put it mildly, to publish comparisons between electricity and suction gas purely on the basis of the cost of fuel under the latter head.

So far, we have only considered the question of a large factory, but for small users, especially if the demand is an intermittent one, there can be no question as to the advantage of a motor connected to the public supply being far more economical both in running costs and capital charges than a gas engine, whether combined with a suction plant, or driven by town gas. We can hardly imagine, for instance, anyone going to the expense of installing suction gas apparatus for driving a countershaft from which a lathe or two are driven.

A word or two might be said with reference to the comparative costs of electricity and town gas, given in the tables already referred to. We have explained why such figures, if true, do not by any means represent the whole case. But are these figures to be relied on? We think not.

We quote again from the *Gas World* of the 21st inst.:—"Taking at hazard the figures given for Plymouth, the price charged for gas is stated as 1s. 9d. per 1,000 cb. ft. . . . . The cost for power from the gas engine in Plymouth is given as 0·38d. per B.H.P.-hour, which assumes a consumption of gas per H.P.-hour of 18·1 cb. ft., which may be considered a fair average figure." Reading between the lines, the *Gas World* thinks it is, if anything, rather low, but does not care to admit it. Now, 18 cb. ft. seems to be about the average figure on which these tables are based, and it should be noted that no mention is made of whether it refers to large or small units, or for partial or full load. The average load on a gas engine in ordinary commercial use is something considerably under full load, and for comparatively small engines lightly loaded, this figure is ridiculously small for town gas of average calorific value. Indeed, the uniformity with which 18 cb. ft. per B.H.P.-hour is taken in the different towns quoted, is somewhat startling, and leads us to wonder how the figures were arrived at.

We have recently made inquiries of a small printer who has had his 1-B.H.P. gas engine replaced by an electric motor, in order to find out how much gas he used per quarter, and what hours he ran his engine. The result of careful inquiries showed that although the normal load of the engine was considerably under 1 B.H.P., it used on an average no less than 30 cb. ft. of gas per hour. This figure agreed with rough tests taken by him on several occasions, when he took readings of his meter before and after a day's run.

The change to electric driving, which was made nearly two years ago, has resulted in a saving which will soon pay for the cost of the motor. Anyone who has had much experience in the running of gas engines will, we feel sure, agree with us that the figure given by our contemporary, namely, 18 cb. ft. per B.H.P. per hour is quite out of the question with ordinary town gas, if taken as an average for engines of all powers, of all ages, and running under all conditions of load.

The small engine we have quoted, with its 30 cb. ft. per hour is not abnormally inefficient as such engines go, even when taking into consideration the fact that it was not on an average running at more than two-thirds of its full load, which means, say, 45 cb. ft. per B.H.P. per hour.

A small gas engine *when new* will take about 30 cb. ft. per B.H.P. per hour, and a large one as little as 17, both when running at *nearly full load* with gas with a calorific value of about 680 British thermal units per cb. ft.

Now, if one takes an average of all engines running in a given town, as one is led to believe the compilers of the tables referred to have done, it is only reasonable to suppose that many are antiquated and inefficient, and of small size, while most of them are running for a considerable proportion of their total running hours at very small loads. We might leave the old engines out of the question, as the tables are, perhaps, meant to refer to the best that can be done under working conditions, but we cannot ignore the fact that such conditions must of necessity include light loads, and small engines. Hence we cannot accept such a figure as 18 cb. ft. per B.H.P. per hour, neither can we put any faith in tables, however voluminous, which are based on such a figure or on anything approaching it.

Any reliable figures are difficult to obtain, which can be taken as applicable to gas engines in general, as the conditions of running are so extremely varied. The only reliable data are the yearly costs of power users who have tried both gas and electricity, and cases are legion in which the latter system has resulted in a very substantial saving.

REVIEWS.

Transactions of the American Electrochemical Society. Vol. VI. 1904. Published by the Society, 39, South Tenth Street, Philadelphia. Price $3 net.

The *Transactions* of the active and enthusiastic body that guides the destinies of electro-chemical progress in America is always a volume of considerable interest, but the issue now before us, containing as it does the papers read in September, 1904, at the International Electro-chemical Congress, St. Louis, is a volume of quite special interest and importance.

If it is safe to assume that the nature of the subjects discussed at St. Louis is an indication of the present status of electro-chemistry in America, one can then perhaps infer that there is for the moment a lull in the extraordinary activity on the side of industrial applications, that has been the chief characteristic of trans-Atlantic electro-chemical science for the past 10 years, since, let us say, the opening of the Niagara Falls works of the Pittsburg Reduction Co., which took place on August 26th, 1895, just about a decade ago. But although no new industrial development of striking importance is here recorded, still there has been much careful research, and this, as always, has been accompanied by substantial practical progress.

The wide variety of the subjects discussed, and what is more, the healthy combination of theory and practice, and the keen attention that is given by all parties without favour to both these equally important aspects of their special science, are features of these as of all previous *Transactions* that cannot fail to impress favourably the most heedless observer. How refreshing it is to find a stern and rigid "pure" chemist like Dr. Bancroft discussing the chemistry of electro-plating—in spite of the fact that it seems to take us little further forward! How refreshing and exhilarating are these excursions into theory which can never fail to delight—even if they sometimes pain—the musty old orthodox pedant of this side of the Atlantic, who has been brought up on academic conventions made in Germany, with their stupid and tiresome adherence to facts!

Where there is so much that is interesting and valuable, it is perhaps invidious to single out papers for individual mention, but those that contain novel points which happen to appeal to us as being of some special practical interest are:—"The Use of Carbon for the Study of Temperatures in

the Electric Furnace," by F. A. J. FitzGerald (change of density is the property made use of); "Electrical Extraction of Nitrogen from the Air," by J. S. Edström; "The Lead Voltameter," by A. G. Betts and E. F. Kern (a useful and suggestive paper); and "The Electrolysis of Fused Salts," by Richard Lorenz. It is a somewhat melancholy comment on Mr. Edström's paper that the Atmospheric Products Co., which has been working the Bradley and Lovejoy patents for the fixation of the nitrogen of the air, has now, for the present, ceased operations. Let us hope that the Birkeland & Eyde process described by Mr. Edström, in which some hundred arcs per second are formed, carried forward, and extinguished by the deflection caused by a magnetic field, will have a happier fate. As the efficiency claimed for it is already 900 kilograms of nitric acid per kilowatt-year, the outlook for its future is decidedly promising. This is a problem that the electrochemist is bound to have to solve sooner or later.

Commercial Economy in Steam and other Thermal Power Plants. By Robert H. Smith. London: A. Constable and Co. 1905.

This book is really much too learned to be of much use to those to whom we should suppose its author has intended it to be useful. Moreover, an author who seems to have so strong a penchant for engineering as controlled by commercial considerations has, in our opinion, a style that is hardly consistent with a book for the mere commercialist. That there are many and valuable diagrams in the book no one will deny, but they will be treated rather with respect than used with familiarity, exactly as one sees objects of veneration carefully cushioned on the window tables of whole rows of houses and never used. The author is, moreover, difficult to read. It is laborious to follow him, and—but perhaps this is our own shortcoming—we confess to a feeling of irritation over what has been termed Smithese, or the author's special and particular language, and his use of words of his own invention, such as *transpower*, heat transpower. Then, on page 206, he heaves at his readers the word *isoresilient*, and immediately substitutes for it *isoresalic*, or more simply *isosalic*, thus not only making a word, but changing it and boiling it down, and then giving a reason for the eliminatory process he has carried on before your eyes as though he were a lecturer on philology, and not simply striving to make straight the path of the untaught, illiterate commercial engineer, who, in the majority of cases, will fail to grasp the author's meaning. In Germany everything is "stoffe." Thus we have Sauerstoffe, which means oxygen, and Kohlenstoffe, which is what the Kaiser's people call carbon. But we dislike to see English professors reduced to calling steam in the cylinder of an engine by the name of stuff, simply because it is partly water, and, therefore, incorrectly defined as steam. In this stuff business, however, the author only follows another worthy professor. At p. 155 we have a discussion as to the propriety of employing some more new words—such as meta-power, muta-power, alter-power, endo-power, engen-power, so as to conduce to clearness of thought. Now, in this they fail, and it is a pity the author should strive so much after mere words, and lose touch with English readers by the complexity of his diction, thus reducing the value of an undoubtedly clever piece of work.

We take it that the author has had in view the treatment of steam and heat engineering generally from the commercial side of the question, and that he would endeavour to inculcate the much neglected fact that the highest economy in one direction by no means implies an all-round economy.

Let us quote from the author's preface here. He writes:—"The main endeavour of this work is to persuade the mechanical engineer to advance from the primitive view that engineering science can guide him only in the physical construction and the physical dynamics of his machinery, to the much more complete idea that scientific method must also be applied to his reckonings of cost, and of value produced. The ultimate triumph of practical science must be evidenced in its demonstration of the means to attain Maximum Economy. Physical Efficiency is our factor in Economy. But the only true economy is our all-round economy, and mechanical pride in the difficult attainment of purely physical excellence must leave unshaken our readiness to sacrifice mechanical perfection to low cost in such degree as yields the best economic ratio of resulting value to working expenditure." Thus, throughout, the author appears to be saturated with a German spirit, even to the plethora of capitals in numerous quite unnecessary places. Indeed, in respect of the use of the capital, the author goes, if possible, beyond German practice.

The diagrams, credited to Mr. Hodgson, are simply "curves" on squared paper, showing such things as engine costs for various classes of engines, as related to cylinder capacity and piston speed and steam pressure. Other diagrams are for gas engine costs.

Another diagram is for economic furnace temperature and minimum heat cost for various chimney temperatures, as to which the author makes the excellent remark that chimney temperature ought to be first decided on and based on the steam temperature, since the last portions of heating surface are feebly effective in accordance with the approximation of flue-gas and boiler temperature.

It would be ungracious to criticise too unfavourably a book which gives evidence of an enormous amount of labour, and we do not doubt that, to close students, the book may be welcome, but its mastery will, we fear, overtax the limited hours of the practically engaged man, who cannot afford to puzzle over the words in which it is endeavoured to convey to him the author's meaning. We cannot approve of the use of such florid language or of the abuse of English in the use of such a manufactured word even as "nextly," as on page 102, and we think that, could the author put his thoughts into simpler and more homely form, they would be better understood by his readers. Put briefly, it seems to us that those who can understand the author and his methods and mathematics will be already clever enough to do without this book, while those to whom the book would have been useful if re-written in the style of the "The Compleat Angler," will fail to obtain the good out of it in its present form, and be rather tempted to exclaim, "How many things are there in this world of which Diogenes hath no need!"

OSMIUM LAMPS.

Experiments have been carried out recently at the Technological Institute of Vienna on the average life and power consumption of osmium lamps. Six lamps of 35 volts and 16 c.p., and six lamps of 35 volts and 25 c.p., were employed for testing purposes. The lamps were connected three and three in series, and the groups thus formed were placed on an alternating current circuit at 105 volts. The horizontal luminous intensity and the consumption were measured every 100 hours, until the lamps were destroyed. The results obtained were as follows:—

A lamp of 16 c.p. gave at first 15·1 c.p., with a consumption of 1·68 watts per candle-power. After 400 hours, the luminous intensity increased to 17·3 c.p., and at the end of 2,100 hours fell again to 15·6 c.p. The consumption went down to 1·46 watts per candle-power, and then went up to 1·58 watts.

Another lamp of 16 c.p. gave at first 15·2 c.p., then 17·5 after 400 hours, and 16 at the end of 2,200 hours. The corresponding power consumptions were 1·62, 1·43 and 1·535 watts respectively.

A lamp of 24 c.p. gave at first 22·35 c.p., then 24·6 after 600 hours, and 23·7 after 1,700 hours. The power consumptions were respectively 1·65, 1·51 and 1·56 watts.

Finally, a lamp of 23 c.p. gave 22·25 c.p. at first, 24·1 c.p. at the end of 300 hours and 22·6 c.p. after 2,100 hours, the corresponding power consumptions being 1·65, 1·53 and 1·61 watts.

The following are the conclusions to be drawn from these tests:—

The average life of the lamps was 2,200 hours, the limiting values being 1,793 and 3,036 hours.

Among the lamps tested, three alone presented a diminution in light of 10 per cent., one after 1,750 hours, the other after 940 hours, and the third after 820 hours.

In taking as basis the lamp which diminishes 10 per cent. in luminous intensity, the average life is found to be 1,985 hours, and the average power consumption 1·60 watts per candle-power for a lamp of 16 c.p. and 1·80 watts for a lamp of 25 c.p.

These tests were originally described in a recent number of the *Zeitschrift für Elektrotechnik*, and it must be borne in mind that the candle-power is given in terms of the Hefner candle, so that the power consumptions must be increased by 13 per cent. to correspond with British standard candles.

TABLE OF ELECTRIC SUPPLY STATIONS OF AUSTRALASIA.—Corrected to August, 1905.

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Locality.	Date of commence't. of supply.	Supply authority.	Engineer or manager.	Secretary or Town Clerk.	System employed.	Voltage at consumers' terminals.	No. of consumers.	No. of incand'sc't lamps, equiv. 16 c.p.	No. of arc lamps.	Horse-power in motors.	Capacity of plant. kw.	Capacity of plant. Equiv. 16 c.p. lamps.	Boilers. No. and horse-power.	Engines. No. and horse-power.	Dynamos. No. and kilowatts.	Price per unit. Lighting.	Price per unit. Power.	Price of gas in neighbourhood.	Remarks.
Sydney ..	1904	Corporation ..	T. Rooke ..	T. H. Nesbitt ..	A.C., 3-ph...	240 & 480	273	15,000	424	900	2,700	25,000	5 × 700 H.P. B. & W.	2 × 1,000, 1 × 500 Ferranti, 2 × 1,000 W'lans	4 × 600 & 1 × 300 kw. Dick-Kerr 3-ph.	4½d.*	2d.	4/-	
,, ..	1897	Empire E.L. Co.	J. R. W. Gardam	E. W. G. Strange	D.C... ..	200	405	12,200	..	405	587	9,392	4 × 140 H.P. B. & W.	3 × 90 H.P. & 2 × 165 Alley & Maclellan, & 1 × 300 Willans	3 × 60 kw. & 2 × 110 kw. Parker & 1 × 187 Laurence, Scott	4½d.*	2d.	4/-	115 Tudor cells.
,, ..	1894	George Adams ..	W. J. Adams ..	A. E. Blair ..	D.C., 2-wire	110	..	8,000	115	150	500	8,160	2 × 150 1 B. & W.	1 × 400, 2 × 153, 1 × 60 H.P. Willans & 1 × 30 H.P. Westingh.	1 × 240, 2 × 90, 1 × 45 kw. Siemens & 1 × 36 kw. Parker	4½d.	2d.	4/-	
,, ..	..	Strand E.L. Co.	John Kent ..	..	D.C., 3-wire	110 & 220	..	16,000	..	230	858	14,300	7 × 150 H.P. multitubular	2 × 150 H.P. Univer. 6 × 150 H.P. Willans	2 × 110 kw. Brush, 2 × 125, 2 × 46 Siemens, 1 × 50 Royce	4½d.	3d.	4/-	Public lighting only.
,, ..	1898	Oxford St. E.L. [Co.	H. Langer ..	C. Weber ..	D.C., 2-wire	220	60	3,000	100	75	222	3,700	1 multitubular ..	4 × 300 H.P. ..	4 × 186 kw. ..	4½d.	3d.	4/-	
Redfern ..	1892	Corporation ..	J. W. Balfour ..	R. W. Grierson	A.C., 1,000 v. 70 cycles	200	150	5,914	201	89	240	3,800	2 × 200 H.P. mult., 1 B. & W. 140	2 × 200 H.P. Hor. Comp.	2 × 120 Mather & Platt	5½d. & 2½d.	2½d.	4/-	Public lighting by 150 G.E. series alternating enclosed arcs and constant current transformers, also 120 25-c.p. series incandescent lamps.
Tamworth	1889	Municipal Coun.	W. G. Counsell	W. Hughes ..	D.C., 2-wire	220	..	250	10	Nil	47	800	2 × 30 H.P. multitubular	2 × 30 H.P. comp. Fowler undertype	1 × 22, 1 × 25 kw. Crompton	..	..	7/6	Public lighting only. Extensions for private lighting in view.
Penrith ..	..	Corporation ..	D. H. Stewart ..	..	A.C., 1,000 v. 100 cycles	50 & 100	..	850	1	Nil	40	640	1 × 80 H.P. Marine	2 × 30 H.P.	2 × 20 kw. B.T.H.	..	..	..	£1 5s. per lamp year.
Broken Hill	1890	B.H.E.L. and P. station	F. J. Mars ..	..	A.C., 1,100 v. 100 cycles	220 & 110	160	2,500	40	30	220	3,500	3 × 90 H.P. B. & W.	2 × 100 H.P. Westgh. 1 × 200 H.P. Belliss	1 × 70 kw. A.E.G. 1 × 50 kw. Mordey 1 × 110 kw. Brown	1/- & 6d.	6d. & 3d.	12/6	220-volt single-phase motors.
Hillgrove ..	..	Hillgr. and Armidale E. Cor. Ld.	A. L. Cadogan ..	E. J. Erskine ..	A.C. light .. D.C. power	110 & 1,500	60	528	2	200	530	8,500	Water-power ..	..	3 D.C., 2 A.C. Crompton	..	..	None	Power for mining.
Mossvale ..	..	M.V.E.L. Co. ..	W. Clegg ..	H. Richardson ..	A.C.	100	30	400	Nil	Nil	38	600	25 & 8 Lcc.	Willans	Mordey	6d.	..	..	
Newcastle	1891	Corporation ..	Jas. Hirst ..	E. S. Holland ..	A.C., 1,000 v.	..	Nil	630	23	Nil	90	1,500	2 × 86 B. & W. ..	2 × 130 Westgh. ..	2 Westinghouse ..	..	..	4/7	Public lighting only.
Young ..	1888	Corporation ..	E. M. Grant ..	C. M. Reeves ..	A.C., 1,000 v. 125 cycles	52 & 104	156	1,126	3	Nil	75	1,200	2 90 H.P. Multilocomotive	2 Fowler Undertype Comp.	3 T.H., 25 kw. ..	8d.	..	None	Rate per 16-c.p. lamp, 5½d. and 8d. per week.
Melbourne	1894	Corporation ..	H. R. Harper ..	J. Clayton ..	D.C. & A.C.	230 & 100	1,588	49,255	1,578	1,442	3,184	49,800	4 × 250 B. & W. 4 × 500 ,, ,, 2 × 500 Stirling	5 Belliss, 1 Peache (comp.); 4 Aust. Otis Robey type, 1 × 1,000 Allen	4 × 75 T.H. Altrs., 1 × 150 Johns. & P. 4 × 350, 1 × 200 P.ds. 24 T.H. Arc Lts., 1 × 750 Crompton	4½d.†	2d.	5/-	D.C. 3-wire in centre of city. A.C. 2,000 volts in outskirts.
,, ..	1889	E.L. & T. Co. ..	F. W. Clements	W. J. Mountain	A.C., 4,000 v. 50 cycles	200	887	20,079	414	687	1,200	20,000	8 × 250 H.P. B. & W.	2 × 900 H.P. & 1 × 400 Brush Univers.	2 × 500 & 1 × 200 kw. Brush Alts.	6d.	2d.	5/-	Condensing, economisers.
Geelong ..	1901	E.L. & T. Co. of Australia	G. G. Jobbins ..	W. J. Mountain	D.C., 3-wire	220	392	5,037	132	428	500	8,000	3 Semi-marine, 1 Stirling	3 Belliss Comp'd.	2 × 100 & 1 × 300 3 × 25 kw. Brush	7d.	2½d.	6/8	Surface-condensing, 252 Tudor cells.
Bendigo ..	1892	E.S. Co. of Vic.	B. Sluytermann	G. S. Morison	A.C. & D.C.	100	112	1,950	81	76	165	2,600	4 × 70 H.P. B. & W.	5 × 70 H.P. Comp...	4 × 12 kw. Arc ltrs. 1 × 40 kw. Ganz A.C.	8d.	8d.	8/4	
Ballarat ..	1894	E.S. Co. of Vic.	..	..	D.C., 3-wire	..	..	..	...	..	122	200	..	..	..	..	..	..	
Nhill ..	1891	N.E.L. Prop. Co.	J. C. Lockley ..	..	D.C.	...	...	..	..	..	31	650	..	90 H.P.	..	..	..	..	
Moolort ..	1901	D.L.E.T. Co. ..	H. A. Thomas ..	..	3-phase ..	6,600	...	..	..	..	1,200	20,000	6 × 250 B. & W. ...	3 × 750 Buckeye ..	3 × 400 G.E. Co. ..	..	..	..	Power for mining only.
Brisbane ..	1888	City E.L. Co., Ltd.	E. C. Barton ..	W. M. l'Estrange	D.C., 3-wire	110 & 220	294	3,482	129	100	375	6,200	3 Lancashire, 7 × 20 Economiser, 144 tubes	1 × 80 Raworth, 1 × 80 Robey, 1 × 80, 1 × 120, 1 × 240 Parsons	2 × 50 Parker, 1 × 50, 1 × 75, and 1 × 150 Parsons	3d.	3d.	6/8 less 22½%	Output 711,000 units; 2 elec. furn., 2 X-ray apparatus, 2 elec. baths; putting in fourth boiler and 200 kw. plant.
Charters Towers	1897	C.T.E.S. Co. ..	F. W. Warden ..	A. W. Wilson ..	A.C., 2,200 v.	100 & 200	150	1,713	Nil	Nil	250	3,830	3 × 80 H.P. Cornish	2 × 70 H.P. Browett 1 × 200 Parsons	2 × 40 kw. Crompton, 1 × 150 Parsons	1/6 & 6d.	..	13/4	Charge on sliding scale.
Rockhampton	1892	R.G. & C. Co., Ltd.	W. T. Nye ..	A. Lloyd	D.C., 2-wire	110	53	520	18	10	47	800	2 Knapps, Root ..	Paxman, Globe, Westinghouse	Hookham, Brush, Crompton	1/- & 9d.	7d.	10/-	3-wire laid, running 2-wire.
Thargomindah	1894	Shire Council ..	G. A. Lewis ...	R. Speedy ..	D.C., 2-wire	200	25	75	..	..	10	150	Water-power ..	..	..	..	..	None	Price 1/- per lamp per week.
Adelaide ..	1900	Adelaide Electric Supply Co., Ld.	F. W. Wheadon	H. Ashworth ..	D.C., 3-wire A.C., 2,000 v. 50 cycles	200	650	13,757	225	818	760	13,000	4 × 212 H.P., B. & W.	2 × 260 & 2 × 360 H.P. Willans, 2 × 150 H.P. Tosi	2 × 100 and 2 × 200 kw. Bruce Peebles, 2 × 80 kw. Ganz	7d. or 8d. & 3d.	2½d.	6/-	Economiser, condensing, cooling-tower.
P't Adelaide	1899	,, ,,	,, ,,	,, ,,	D.C., 3-wire	200	114	2,131	72	31	120	1,900	3 Cornish	5 Alley & Maclellan	5 Johnson & Phillips	7d. or 8d., 3d.	2½d.	6/8	
Hobart ..	1898	H. Gas Co. ..	H. J. Spencer ..	W. J. Campbell	A.C.	110 & 220	150	4,500	165	90	252	5,040	1 160 loco., 2 B. & W. 180 multi	2 × 160 Willans, 1 × 80 Crossley gas	2 × 100 kw. Siemens, 1 × 52 Siemens	8d.-4d.	3d.-1d.	6/8-6/3	Extensions in hand.
Launceston	1896	Municipal Coun.	Wm. Corin ..	C. W. Rocher ..	3-phase, 5,000 v.	110 & 190	2,600	16,298	186	309	1,200	20,000	Water-power ..	4 × 500 Kolben turbines	4 × 300 Kolben ..	6d.- 1½d.	2d. & ½d.	7/1 & 6/8	Max. demand indicators, 3-phase 4-wire distribution.
Devonport	1903	Town Board ..	G. H. Lofts ..	B. C. Greene ..	D.C., 3-wire	220	175	1,600	30	6	96	1,600	1 × 75 Climax, 1 × 100 B. & W.	2 × 75 Belliss ..	2 × 48 Brush ..	8d.-3d.	3d.-2d.	None	Max. demand indicators; Reason & Bastian meters; large extensions projected; steam superheated; free lamp ren.; battery, 240 Tudor cells.
Zeehan ..	1900	Zh. E.L. & P. Co.	A. H. Warden ..	..	D.C., 3-wire	220	..	..	..	..	..	..	..	1 × 100 Brush Falc.	2 × 22 kw. Brush	1/-	..	None	

Locality.	Date of commencement of supply.	Supply authority	Engineer or manager.	Secretary or Town Clerk.	System employed.	Voltage at consumers' terminals.	No. of consumers.	No. of lamps connected.	No. of motors.	Horse-power in motors.	Capacity of plant. kw.	Capacity of plant. Equiv. 16 c.p. lamps.	Boilers. No. and horse-power.	Engines. No. and horse-power.	Dynamos. No. and kilowatts.	Price per unit. Lighting.	Price per unit. Power.	Price of gas in neighbourhood.	Remarks.
Perth	1893	Perth Gas Co., Ltd. [Co. Ld.	H. Broadbent ..	T. Blackney ..	D.C., 3-wire	220	2,000	35,000	250	500	1,515	24,250	4 × 106, 2 × 500, 2 × 1,000 H.P. B. & W.	4 × 80 & 3 × 160 H.P. & 2 × 850 Willans	4 × 50, 3 × 105 Castle & 2 500 Dick-Kerr	7d.-3d.	5d.-2d.	7/6	Mec. stokers, cond., new p.h., no public l., cool. t.
South Perth	1905	S. Perth E.S. & P.	H. A. J. Bader..	M. M'L. Goldie	D.C., 3-wire	220	..	260	Nil	4½	50	850	2 × 40 H.P. B. & W.	2 × 40 Belliss & M.	2 25-KW. E.C. Co.	10d.†	8d.†	..	154 incand. street lights.
Kalgoorlie	1901	K. Pow. & Lt. Co.	C. E. Crocker ..	..	3-phase ..	550	..	..	..	..	1,500	24,000	8 × 300 B. & W. ..	3 × 800 H.P. Stewart	3 × 500 G.E. Co., 1 × 500 Dick-Kerr	9d.-5d.	6d.-3d.	..	Fouché aerial condensers used.
„	1898	Municipal Coun.	D. Curle Smith..	E. E. Hawkins..	D.C., 3-wire	220 & 440	1,100	10,000	70	130	750	12,500	3 × 250, 2 × 65 B. & W.	2 × 75 Willans, 3 × 150 Alley & M' L., 2 × 330 Parsons tr.	2 × 35 KW. Holmes, 3 × 84 KW. Parker, 2 × 200 Parsons	7d.	4d.	None	Street lighting, 750 8-C.P. + 40 arcs; mains in 24 miles streets.
Coolgardie	..	E. S. Co. of W.A.	..	..	D.C.	220	..	..	..	..	220	3,500	..	2 × 200 H.P. Willans	2 × 120 ..	..	..	..	
Boulder	1899	Corporation ..	J. Schmidt ..	E. J. Powell ..	D.C., 3-wire	220	200	6,000	60	40	258	4,160	2 B. & W., 106 H.P. each, 2 Buttoner Water Tubler 2 × 160 H.P.	2 Sturtevant 32 H.P., 1 × 80 do.; 1 × 60 1 × 200 Willans	1 × 40, 2 × 17½ Sturt. 1 × 33 Siemens 1 × 150 Helios	1/-	1/-	None	Tudor battery, 318 ampere-hours; A.F.A. Berlin.
Claremont	1905	Municipal Coun.	F. Wilkinson ..	W. St. Brockway	D.C., 3-wire	230	156	2,500	3	..	130	2,200	2 × 75 H.P. B. & W.	2 × 120 H.P. Willans	2 × 60 KW., E.C.C. ..	7d.	..	..	Street l., 200 32 & 16 C.P. lamps.
Bunbury	1903	Splatt, Wall & Co.	A. F. Williamson	Splatt, Wall & Co.	D.C., 3-wire	220	225	2,700	18	6	60	1,000	2 × 90 Paxman Econ.	2 Sturt. hor. 55 H.P.	2 Sturt. mult. 30 KW.	10d.	..	..	New set accumulators ordered.
Subiaco	1903	Municipal Coun.	W. R. Groom ..	A. Rankin ..	D.C., 3-wire	220	300	3,000	7	3	72	1,150	2 × 75 B. & W. ..	2 × 65 Pax. Peache	2 Cromp. mult. 36 KW.	7d.-5d.	..	7/6	Street l., 140 32-C.P. incan., 7 arc lamps; tender for plant.
Cottesloe, Buckland Hill, and Peppermint Gr.	1901	Splatt, Wall & Co. (Private Act of Parliament.) ..	Splatt, Wall & Co.	Splatt, Wall & Co.	D.C., 3-wire	220	210	3,000	5	80	90	1,450	1 × 150 H.P. B. & W., 1 × 150 Hornsby upright water-t.	2 × 50 H.P. Sturtevant, 1 × 75 Robey, 1 × 50 Westinghouse	1 × 20 KW. Cromp., 1 × 15, 1 × 20 Sturt., 1 × 35 Bergm.	9d.	6d.	..	100 incan. street lights; 400 amp.-hour Chl. acc.
Northam	1901	Municipal Coun.	R. M'Donald ..	B. J. Smith ..	D.C., 3-wire	220	180	2,500	10	12	112	1,450	1 Pax. Econ., 1 Bab.	2 Sturt. hor. 150 H.P.	2 × 40 and 50 Sturt.	9d.-7d.	6d.	..	[before 10th inst.
Midland Junction	1902	Municipal Coun.	E. Bindley ..	D. Pascoe ..	D.C., 3-wire	220	130	900	5	..	50	833	2 Paxman Econom.	1 × 75 Sturtevant	50 KW., 8-pole ..	7d.	..	..	Current less 1d. per unit if paid Municipal and private lighting.
Kookynie	..	Electric Co. ..	S. Tatham ..	..	D.C., 220 v.	220	50	500	10	..	50	..	Hornsby loco. ..	Tangyes, M. & P.	Sturtev., M & P. ..	..	1/6d., 1/-	..	
Fremantle	..	Municipal Board	A. Mitchell ..	..	½-phase, 3,000	220	..	..	..	..	600	..	4 × 200 H.P. B. & W.	4 × 210 Belliss ..	1 × 150 Westgh. ..	..	..	..	Plant to start in November.
Wellington	1888	W. E.L. & P. Co.	G. S. Maben ..	G. G. Townsend	A.C., 2,000 v. 80 cycles	100 & 200	3,132	51,377	210	820	1,525	25,000	4 × 130 H.P. Econ. 4 × 212 H.P. B.-W. 2 × 700 H.P. B.-W.	3 × 600 Browett, 1 × 550, 1 × 300 Brush, 3 × 150 Paxman	3 × 300 KW. West., 1 × 250, 1 × 150 Bsh., 3 × 75 Gulcher	5d.-1/.	3d.	5/10	Street light. by 950 incan. lamps, 20 C.P. each, and 35 arcs of 15 amperes each.
Rotorua	1901	N.Z. Governmnt	R. C. White ..	..	A.C., 4,000 v. 50 cycles	100	..	1,500	20	20	100	1,600	Water-power ..	2 × 100 H.P. Waverley turbines	2 × 50 KW. Brush inductor	6d.	..	None	13-mile transmission, sewerage pumping. Ext. in hand.
Christchrch	1903	Corporation ..	W. D. Wilkinson	H. R. Smith ..	D.C., 2-wire	220	200	4,000	80	300	350	5,600	2 × 250 B. & W. ..	2 × 160 & 1 × 250 Davey Paxman ..	2 × 100 Westgh. 1 × 150 B. T.H. Co.	6d.- 3½d.	2½d.	5/9	Meldrum ref. destr. Bat. 124 Tud. c. 1,000 ampere-hours.
New Plymth	1905	Municipal Coun.	H. Black.. ..	F. T. Bellringer	A.C., 2,000 v. 50 cycles	220 & 440	..	..	..	..	90	1,500	2 × 67 H.P. Gilbert Gilkes turbines		2 × 45 KW. Brush.	..	..	8/4	4-mile transmission.
Stratford	1899	Stratford E.S. Co. [P. Co., Ltd.	W. J. Newton ..	J. H. Thompson	A.C., 2,000 v. 40 cycles	100	275	2,543	2	..	90	1,450	Water-power ..	2 × 75 twin turb...	2 × 45 Brown Boveri	9d.	7d.	None	
Inglewood	1905	Inglwd. E.L. &	W. Richardson	E. R. A. Haworth	A.C., 3-ph.	220	100	450	..	40	90	1,500	Water-power ..	Turbines	2 × 45 Int. E.E.Co.	7d.-1/.	Contr.	None	[to number.
Patea	1902	Municipal Coun.	H. Priestly ..	R. W. Hamerton	A.C., 3,000-v. 60 cycles	100	98	918	..	..	50	1,000	Water-power ..	1 × 60 H.P. ..	1 Brown Boveri	10d.§	..	None	Power charged per H.P., according [transp. lamps.
Campbeltwn	1903	Corporation ..	R. Cruickshank	A. M'Clure ..	D.C., 3-wire	220	62	450	12	..	36	570	2 × 70 Multitubul'r	1 × 70 Sc.-Reavell	2 × 18 KW. Intern.	10d.	..	None	Street lights, 34 ¼-ampere and

EXPLANATION OF ABBREVIATIONS.—A.C., Alternating Current; D.C., Direct Current; A.H., ampere-hours capacity; B. & W., Babcock & Wilcox; KW., Kilowatts; B.T.H., British Thomson-Houston Co.; M. & P., Mather & Platt.

NOTE.—Connections to mains are expressed in 16-C.P., 60-watt lamp equivalents, and do *not* include arc lamps or motors, which are detailed independently.

* And 5d. and 2d. maximum demand rate.

† Free incandescent lamp renewals flat rate 5d. per unit, or max. demand system, 7d.-2d.

‡ Less 1d. discount.

§ 2½d. discount, if paid before 10th of month; 4½d. discount over 20 units per month.

ELECTRIC LIGHTING COMPANIES AND COMPULSORY PURCHASE.

[BY OUR LEGAL CONTRIBUTOR.]

THE time is not so far distant when that sword of Damocles—compulsory purchase by a local authority—may descend upon the head of an electric lighting company. Inasmuch as the Electric Lighting Act, 1882, came into force on August 18th in that year, there may be a few companies whose property can be purchased compulsorily within about 20 years from now; while metropolitan companies may be deprived of their undertakings within 42 years from August 26th, 1889—that is to say, on August 26th, 1931. The date of possible compulsory purchase is therefore sufficiently near to render it prudent for the management of every company, when contemplating the acquisition of new premises or the purchase of new machinery, to remember that what is sometimes erroneously called their monopoly is limited as to time.

It may be asked, "Upon what terms will the local authority be entitled to acquire the undertaking of a company? Will there be any allowance for compulsory purchase—any compensation paid for the loss of goodwill? It is to these questions that we shall attempt in the course of the present article to furnish some reply.

The law upon the subject is to be found in the Electric Lighting Acts, 1882 and 1888. Unfortunately, owing to the fact that there has been no case of compulsory purchase under these Acts, their interpretation has not yet formed the subject of discussion in any Court. We shall be able, however, to discuss the meaning of the material sections in the light of certain decisions under the Tramways Acts; for the compulsory purchase of tramways is carried out on principles resembling those which are to be found in the Electric Lighting Acts.

By Sec. 27 of the Act of 1882 it was provided that the local authority might, after the expiration of a period of 21 years (or after every subsequent period of seven years) from the date of the provisional order, purchase the undertaking compulsorily, or so much of the same as was within their jurisdiction, upon certain terms. As it was found that the period of 21 years was too short to give sufficient inducement for the formation of electric supply companies, Sec. 27 of the Act of 1882 was repeated and re-enacted with certain important amendments by the Electric Lighting Act, 1888, Sec. 4.

This section, which now contains practically all the law upon the subject, is in the following terms:—"Where any undertakers are authorised by a provisional order or special Act to supply electricity within any area, any local authority within whose jurisdiction such area or any part thereof is situated may, within six months after the expiration of a period of 42 years, or such shorter period as is specified in that behalf in the provisional order or in the special Act, from the date of the passing of the Act confirming such provisional order, or of such special Act, and within six months after the expiration of every subsequent period of 10 years, or such shorter period as is specified in that behalf in the provisional order or in the special Act, by notice in writing require such under-

takers to sell, and thereupon such undertakers shall sell, to them their undertaking, or so much of the same as is within such jurisdiction, upon terms of paying the then value of all lands, buildings, works, materials and plant of such undertakers suitable to and used by them for the purposes of their undertaking within such jurisdiction, such value to be in case of difference determined by arbitration. Provided that the value of such lands, buildings, works, materials and plant shall be deemed to be their fair market value at the time of the purchase, due regard being had to the nature and then condition of such buildings, works, materials and plant and to the state of repair thereof, and to the circumstance that they are in such a position as to be ready for immediate working, and to the suitability of the same to the purposes of the undertaking, and where a part only of the undertaking is purchased, to any loss occasioned by severance; but without any addition to respect of compulsory purchase, or of goodwill, or of any profits which may or might have been made from the undertaking or of any similar considerations. The Board of Trade may determine any other questions which may arise in relation to such purchase, and may fix the date from which such purchase is to take effect, and from and after the date so fixed, or such other date as may be agreed upon between the parties, all lands, buildings, works, materials and plant so purchased as aforesaid shall vest in the local authority which has made the purchase, freed from any debts, mortgages, or similar obligations of such undertakers attaching to the undertaking, and the powers of such undertakers in relation to the supply of electricity under this Act or such provisional order or special Act as aforesaid within such area, or part thereof as aforesaid, shall absolutely cease and determine, and shall vest in the local authority aforesaid."

The effect of this section has been succinctly stated to be that, at the end of the statutory period, the local authority will be able to purchase an electrical supply undertaking in their district at the price of "old iron." It is interesting to consider the truth of this assertion in the light of the exact words of the section. It is, therefore, necessary to examine certain provisions of the section in some detail.

It will be noticed, in the first place, that the statutory period of 42 years may be shortened in the case of any particular company by the terms of the provisional order.

In County of London orders in favour of companies, it is the practice to provide that the period of 42 years shall run from one fixed date, viz., August 20th, 1889. "The object in view" (according to Mr. Shiress Will*) "is to secure that in the event of a purchase, the whole electric lighting concerns of the metropolis in the hands of undertakers other than local authorities may be acquired at one and the same time." Provisional orders in favour of companies or persons within the county of London, specially provide that the recurring period of seven years for seeking to alter prices or methods of charge shall begin to run from August 20th, 1889.

The recurring period of ten years for purchase is sometimes by arrangement varied in provisional orders. For an instance, reference may be made to the County of London (East) Electric Lighting Order, 1897, Sec. 65, where the period of seven years is substituted. For an instance, where special terms were arranged and inserted in the provisional order regarding time of purchase, price, &c., see Blackheath and Greenwich District Electric Lighting Order, 1897, Sec. 65.

The word "undertaking" is not defined in the Electric Lighting Acts, 1882 and 1888. It was explained, however, as it occurs in the corresponding section of the Tramways Act, 1870, and with reference to tramways, by Lord Watson in London Street Tramways Co. *v.* London County Council ((1894) a.c. 474). He said: "The word 'undertaking' is not defined in the Act, but it appears to me that it must signify all the real and movable property belonging to the promoters necessary for conducting tramway traffic, together with all rights and interests in or connected with such property which belong to the promoters, and are capable of being transmitted from them to the purchaser. I do not think the word can be reasonably construed so as to include any property, or any right or interest, which does not belong to the promoters, and does not pass from them to their purchaser under the compulsory contract of sale. On the assumption that the promoter's privilege of use is personal, and, therefore, limited to the period during which they may continue to be owners of the tramway, the privilege of use after the expiry of that period, which they did not possess, cannot be regarded as part of the undertaking which they are required to sell."

(*To be concluded.*)

* Law of Electric Lighting (1898), p. 54.

THE INSULATION OF CABLES AND WIRES USED BY ELECTRICAL CONTRACTORS.

On Tuesday the 24th ult., a large and representative gathering of the members of Electrical Contractors' Association, assembled at Frascati's Restaurant to hear and discuss a paper by Mr. C. J. Beaver, on "Rubber (and other materials) used in the Insulation of Cables and Wires." Mr. E. L. Berry, who was in the chair, briefly explained the genesis of the paper, which lay in the trouble to which contractors were put by reason of the deterioration which often occurred after good material had been installed. The Association had, therefore, asked Mr. Beaver to prepare a paper which should embody the opinions of manufacturers on the subject, and also the advice which they had to offer.

Mr. C. J. Beaver then explained a key outline to his paper before passing to its specific sections. Cables, firstly, were divisible into three types—(1) cables insulated with vulcanised rubber; (2) cables insulated with paper and lead sheathed; (3) cables insulated with compounds of the vulcanised bitumen type. The causes of trouble or failure were of three classes, (*a*) inferior material or imperfections of manufacture, (*b*) local conditions under which the cable works, (*c*) imperfect workmanship in connection with the running or fixing of the cable. So far as contractors were concerned, Type 1 was generally used for house wiring, Type 2 was occasionally used, but more generally, Type 2 and Type 3 were used for power mains from an isolated generating station to the house or battery-room switchboard. Discussing the component parts of a rubber-insulated cable, the author urged that in damp situations tanned jute yarn was preferable to a cotton braiding. They had to remember that rubber was susceptible to many deteriorating influences, and that these were both external and internal. For instance, the wires must be well tinned, in order to safeguard both copper and rubber; for while the sulphur in the vulcanised rubber attacked the copper, copper in its turn, by means of its catalytic action, acted as an oxygen carrier. It was the cable-maker's duty to supply pure rubber made from finest Para sheet. Inferior rubbers required a chemical preparation, and the chemical residues attacked the copper, in spite of the tinning. Low-grade rubber was invariably mixed with substitutes which were always detrimental to the life of the cable. As to the detection of low-grade rubber, he admitted that this was difficult to the contractor. There were, of course, a scheduled number of specified tests. He cautioned his hearers against relying upon that of the percentage of ash found after burning. The ash only indicated the amount of mineral loading present, and when volatile oil substitutes were used as adulterants, heating merely volatilised these. The test was, therefore, absolutely fallacious as an indication of impurities, and the only court of appeal was the analytical chemist. As regards the other tests, a rough stretching test was the only aid he could commend to the buyer. The "damp heat" and "dry heat" tests could only be carried out by experts. It was important that hard fine Para should be employed in the vulcanised covering, as good vulcanising was most easily effected by standard processes; rubber containing substitutes required variation in treatment which did not make for ease of manufacture or for continuity of grade of product. It was certainly regrettable that the ordinary buyer could never tell whether his cable insulation was low grade badly made, or low grade well made, or high grade badly made, or high grade well made. He (the author) must leave his hearers to draw their own conclusions as to the course they should pursue. (A voice—Go to a good maker.)

As regards deterioration due to local conditions, condensed moisture in the tubing was the most pernicious cause, the

reaction being not so much one of direct percolation, but of subsidiary chemical reactions. The chief enemy was moisture from damp plaster on account of its alkaline constituents. The remedy lay in the ventilation or drainage of the tubes. As for the mechanical damage due to abrasion arising from imperfect tubing, this was not a contingency for which the cable maker should be directly called upon to provide. Personally, he thought that the reduction of the number of draw-in boxes so frequently occurring was to be deprecated. Dampness was worse with wood casing than with tubing. When the cables were lead-covered, the lead should be continuously bonded and suitably earthed. Any corrosion of the lead, however gradual, was certain to be fatal; while these were generally ascribed to chemical reasons, their basis was probably more electrolytic than purely chemical. In regard to bad workmanship, that within the cable factory did not concern his hearers, but he would draw their attention to bad stripping and trimming when connecting wires to fittings. The insulation of the fittings was generally bad. For instances, small wires and cables listed as having an insulation resistance of 600 megohms per mile had often a value of 2,000 megohms per mile; food for thought would be afforded by comparing this fact with that of the insulation resistance of a completed installation. Attention was drawn to the use of other fluxes than resin for jointing. These were all right for exposed work, but for covered wires were liable to creep and corrode both wires and insulation; nothing but resin* should therefore be used.

Passing on to paper-insulated lead-covered cable, they had to remember in using it, whether in buildings or under other conditions, that the lead covering was the only means of keeping it waterproof. The ends needed protection, and the covering must be continuous. The various methods of laying heavy cables, "solid," "drawn-in" and "direct," were described, after which the author proceeded to discuss the troubles incidental to the use of this class of cable. These were fortunately few, and chiefly due to minute lead faults. In the works with which he was associated, they applied hydraulic tests to such cables, which promptly located tiny holes in the sheathing. Other sources of lead trouble were due to impurities; a considerable local galvanic action could arise from lead oxides. Troubles due to local conditions were chiefly electrolytic, and were to be found in made ground, clinkers, ash, &c., and in the neighbourhood of stables, cowsheds or latrines.

Troubles due to imperfect workmanship were rather frequent, it was exceedingly difficult to make labourers cover bare ends. Lead covering must be continuous. Joint boxes should be used, and attention given to the compounds used for filling these, which ought to be fairly plastic at ordinary temperatures, and liquid at 250° F. to 300° F. The prevailing impression was that anything would do for a box compound, but his hearers ought always to go to cable-makers for these. Adjacent lead connections needed to be bonded, and the earth connection in most cases should be near the generating station.

Vulcanised bitumen used for fibrous material was inferior to lead as a waterproof covering, and mechanically weaker, but not subject to electrolytic action. Hardened bituminous compounds should be viewed with suspicion; the loading material used rendered deterioration more liable. Bitumen-covered cables were susceptible to chemical action, particularly from alkaline liquid. Ends should always be protected. Careful workmanship in distributing any local mechanical pressure over as great an area as possible would be an advantage.

In conclusion, Mr. Beaver said that he had spoken from the cable-makers' point of view—he hoped to derive some benefit himself from criticisms based on the contractors' point of view. In cables, as in installation contracts, people couldn't get something for nothing. The inferior contractor begot the inferior manufacturer, and sometimes even temporarily seduced the better class manufacturer from paths of virtue. If they wanted good durable cables they must be prepared to pay the price necessary for high-class material.

In response to the Chairman's invitation, Mr. F. Suter opened what was to have been a discussion, but what was virtually a lengthy series of queries, by asking whether when they used armoured lead-covered cables, it was necessary to earth both armoured sheathing and lead covering, and whether manufacturers supplying lead-covered cables could not attach labels to the coils, giving recommendations as to continuity of sheathing, &c., in order to impress this on their workmen?

Mr. Charles Rawlings asked whether pure rubber covering was, after all, any use as an insulator? Was pure Para best for jointing? His great trouble with india-rubber insulated cables was what to buy. Hitherto his purchases had been based on faith, pure and simple.

Mr. C. Rashleigh Phipps ingenuously inquired what was, after all, the absolute difference between Association and non-Association cable?

Mr. F. E. Petersen, of Messrs. Callender's Cable Co., speaking as a manufacturer, heartily endorsed Mr. Beaver's remarks on the need for good box compounds. Although this was always only a very small item in a contract, it was difficult to get contractors to recognise this. They should remember that the strength of a cable was the strength of its weakest link, and that to use an inferior box compound resolved itself into the deliberate insertion, with malice aforethought, of a dangerously weak link. As to decentralisation in bitumen-covered cables, this did occur. In practice it was due to overloading if cables were all right in the first instance. It was often found at the works that decentralisation did occur in the last few feet of a cable, and that manufacturers had to take special precautions against it. He congratulated Mr. Beaver on presenting what was, from the cable manufacturers' point of view, an able and impartial paper.

Mr. L. G. Tate, who temporarily succeeded in following the previous speaker's example in lifting the debate from the interrogative to the discussive stage, pointed out that, so far as contractors were concerned, rubber-insulated wires for house wiring chiefly interested them. Personally, he regarded the tape covering over the layer of vulcanised rubber as a nuisance, the rubber often being stripped off with the tape. On this account, he had lately purchased wires of small size without tape. Was there any reason why this should not be a general practice? As to analyses, could they rely upon these to tell whether impurities were present in the vulcanised rubber? He had also to speak of some difficulties he had experienced with twin wires lead-sheathed, which he regarded as more susceptible to electrolytic troubles than single wires in lead sheathing. Recently, in a large installation, every section proved to be defective in less than six months, but, by substituting single wires, everything had been satisfactory. With regard to earthing, a proposal had emanated from Glasgow that this should only be permitted through a resistance. He considered that if a leakage did exist on such a system, electrolysis might result, owing to differences of potential between the sheathing and the earth.

Mr. G. F. Ratcliffe raised the question of the effect of non-flammable wood casing. Did this in any way affect the insulation of the cable? Were they right in using rubber solution in the vicinity of a main terminal? Did the manufacturers of cheaper wires tin these effectively? How did the conductivity of cheaper wires compare with standard? What was the best wire to use for fittings, as 3/22 wire would not go through? The speaker then presented two samples of defective cables with their casing, one from a very dry and one from a very wet place, the joists and skirtings in each case being unaffected. The prevailing verdict of the informal inquest which was forthwith held was that the case was one of fungoid growth.

After various other queries, Mr. A. Fearnhead remarked that the author had spoken as a manufacturer, and they welcomed his remarks, but were disappointed that no rough-and-ready test had been commended to them whereby they could judge the properties of rubber for themselves without recourse to the expert. Further, the workman was not, and could not be made careful. In place of coils, could not expensive cables be supplied on small drums? They all knew how careless handling damaged the coils, and that workmen put up wire damaged by their own carelessness. He had also noticed variations in the weight of coils; for

* Have any of our readers tried Venice turpentine?—Eds. Elec. Rev.

instance, some coils of 7/22 cable of the same consignment and same mark showed nearly 1 lb. difference in weight.

After a few more interrogations, the Chairman said that Mr. Beaver had given them a lengthy but very instructive paper. In order that Mr. Beaver might reply immediately, he (the chairman) would forgo his privilege as to speaking, and would leave the author to deal with the questions put to him. It was to be regretted that the paper had been queried, and not discussed.

Mr. Rawlings: We are so ignorant of the subject that we can only discuss it by asking questions.

Mr. Beaver, in reply, said that his Manchester contracting friends said that cables were the only things that gave them trouble. For aught he knew, they might be in the habit of assuring switchmakers that switches were their only worry. He regretted that the paper had been considered undiscussable. His difficulty in its preparation had lain in steering a middle course, and making it neither too elementary nor too technical. Dealing with the specific questions raised, lead-covered steel-armoured cable needed to have both metallic coverings earthed. As for the special labels, this was not a technical, but a delicate, question. Manufacturers didn't presume to teach customers and clients their business. As regards earthing, each installation needed consideration on its own merits. Rubber tape, even pure, was not absolutely waterproof, *per se*, but when lapped on rightly was water-resistant for a long time. The particular value of paper-insulated cables lay in the fact that if the paper had been properly prepared, with a minimum of chemical treatment, it was practically indestructible. He could not advise contractors to buy on any other basis than faith and the reputation of the manufacture. Tests were more or less futile; when less futile they were cumbersome to perform, and the results needed expert interpretation. For purity of rubber, the report of the analyst was the final court of appeal. The main difference between Association and non-Association cables was claimed by Mr. Beaver to be a matter of cheapness and grade of raw materials used. Actual experience as to durability would show the difference; non-Association makers had no standard for rubber, and could use any grade they chose. He thanked Mr. Petersen for his kind and appreciatory remarks. In referring to decentralisation, he had in mind that which was attributable to abnormal working conditions, rough handling and strain. With regard to Mr. Tate's observations, tape should be easily removable from a properly vulcanised wire. He was inclined to think that Mr. Tate had laid himself open to suspicion in that he had inadvertently used low-grade wire. He (the author) knew of no electrical or physical reason for twin-wire lead-covered giving trouble. Perhaps in the case instanced, more care had been taken during re-wiring with single wire. Replying to Mr. Ratcliffe, he had certainly encountered trouble from non-inflammable wood casings. This was due to the deliquescent action of the chemical substances used in giving the wood this property. Rubber solutions contained a solvent material having a softening action, which, when it dried out, left the tape in a somewhat porous condition. Rubber should not be brought into contact with brass or gun metal, unless these had been previously tinned. As to the conductivity of cheaper wires, it was difficult in this country to get anything but high conductivity copper. Cases had been known of poor conductivity in foreign wires. Plaster and cement were always enemies. If initially dry, and subsequently damp, the water therefrom would be alkaline. The suggestion that drums should be used, would undoubtedly be advantageous from the mechanical point of view. The expense would be heavy, there would not only be the cost of the drums, but their carriage. Generally speaking, lead-sheathed paper-insulated wires were best for variable temperatures. For really high temperatures asbestos insulation was best. Bitumen insulated cables were liable to become brittle at cold storage temperature, but were working well in rubber drying stoves at 120° F. Paper-insulated lead-sheathed cables were more permanent if used under proper conditions, but such conditions were not often obtainable. As to very high insulation resistances, megohms were not much to go by, as high values were somewhat fictitious. A high insulation resistance in megohms was chiefly valuable in indicating the condition of the rubber. Specific dielectric strength was of more importance.

In proposing a hearty vote of thanks to Mr. Beaver, the Chairman said that a great deal of light had been thrown on contractors' troubles. Good price, notwithstanding faith, begot good cables. If faith were necessary, manufacturers were certainly endeavouring to produce a good product, and justify that faith.

In acknowledging their cordiality, Mr. Beaver regretted that he could not suggest a hard-and-fast rule for distinguishing bad rubber from good. Could this be done, there would be an immediate end of inferior stuff.

The meeting then adjourned until November 21st, when it was anticipated that a paper would be read on internal combustion engines.

NEW ELECTRICAL DEVICES, FITTINGS AND PLANT.

(*Continued from page* 697.)

Tetley's Switches and Fuses.

Messrs. Tetley & Co., of Falcon Electrical Works, Poland Street, Oldham Road, Manchester, have placed the Falcon "Lightning Break" knife switch, illustrated in fig. 93, upon the market.

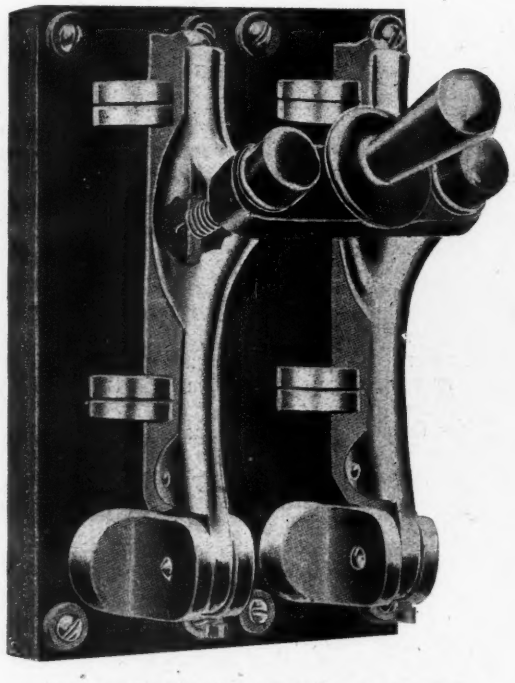

Fig. 93.—Falcon "Lightning Break" Switch.

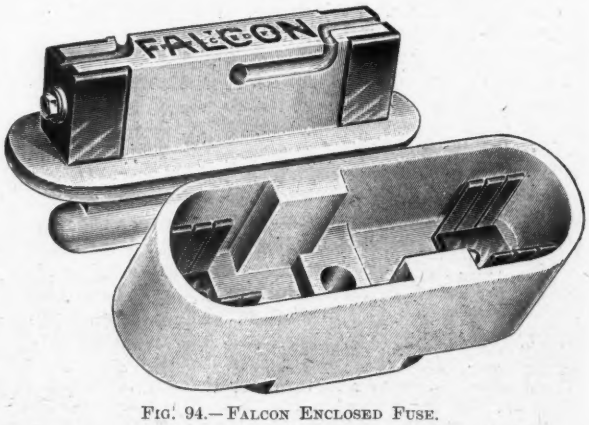

Fig. 94.—Falcon Enclosed Fuse.

This device possesses an independent double line break, which ensures a very rapid and smooth action All current carrying parts

are of high conductivity material and of ample capacity. The essential feature is the total enclosure of the spring and its positive action. It is, of course, a great deal less liable to corrosion than if the breaking mechanism were exposed to the atmosphere. When coupled it is claimed that these switches work in perfect synchronism. All parts are well finished, being either plated, steel bronzed, lacquered brass, coppered, green lacquered, enamelled, &c. We show a double-pole switch.

In conjunction with the "Lightning Break" switch, the Falcon totally-enclosed fuses (fig. 94) are employed. These are made in all sizes up to 100 amperes. We have before us a 10-ampere one for 400 volts.

This fuse has been so designed that the fuse wire is totally enclosed, thereby preventing the escape or scattering of molten metal, when the fuse blows. Owing to the cover carrying the fuse wire, the latter is easily removed when required, and is capable of being replaced quickly on a live circuit without shock or injury to the operator. Another point is that there is a solid block of porcelain between the two contacts and a large explosion chamber at each end. The chambers are of such a size that they allow sufficient radiating surface for the air or vapour given off by the molten metal to be rapidly cooled whenever the circuit is ruptured.

The Wollaston Water-Softener.

Messrs. Isaac Storey & Sons, Ltd., of Empress Foundry, Manchester, have acquired the sole rights for manufacturing and supplying the water-softeners and purifiers constructed in accordance with the patents of T. Royland Wollaston, M.I.M.E., which has been before the public for about five years. The apparatus operating on these principles is claimed to be capable of performing all the following processes positively, continuously, and with very little attention, at all rates of working not exceeding the normal, viz.:—

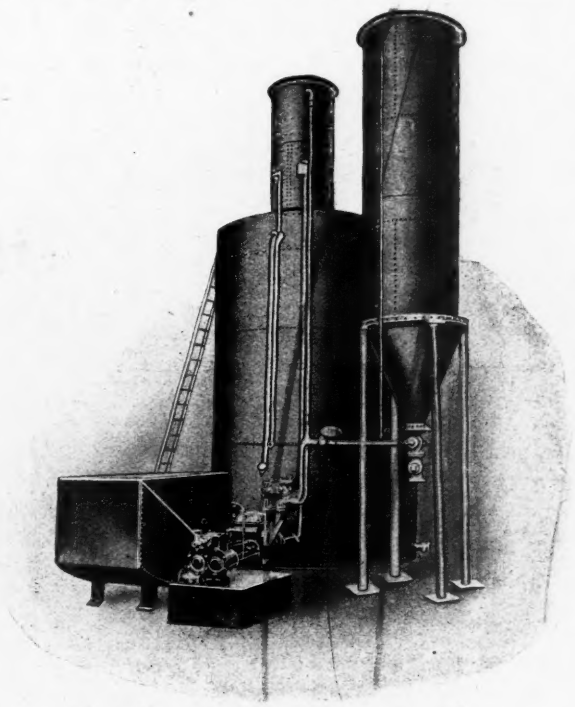

Fig. 95.—Wollaston Water Softening Plant.

1. Breaking up and, where practicable, heating the water to free the excess of carbonic acid gas.
2. Mixing thoroughly with the water exactly the right quantities of reagents, and allowing a certain period to elapse for the chemical action to take place.
3. Abstracting from the softened water the precipates released.

The Wollaston softener being offered by Messrs. Storey to-day has essentially the same features as when it was first introduced, these being the cascade form of heater, the heavy sludge tank, and the patent clarifying tank, but several important additions have been invented and embodied. In fig. 95 we show this softener as installed at a colliery in the North of England. In fig. 96 a diagram appears of a Wollaston softener for lime and soda treatment, which represents current practice.

The reagent tanks, two in number, are used for alternate days, one being available for charging at any convenient time, whilst the other is working. The hard-water pump delivers the untreated water to the top of the heater, where, falling from tray to tray, it is thoroughly broken up. Live or exhaust steam is introduced to the lower part of the heater and, rising through the sprayed water, is condensed until the water reaches boiling point. At the bottom of the heater are spiral vanes, which give the water a rotary or vortex motion in passing down the central pipe. The reagent solution is drawn from one or other of the reagent tanks by the reagent pump, and is delivered into the heater right in the centre of the vortex, thus being perfectly mixed. This pump, being positively driven by the water pump, must deliver an exactly proportionate amount of reagent, notwithstanding variations in the speed of the latter.

The chemical action taking place in the down pipe and in the heavy sludge tank causes the solids in the solution to be released, and the heavier portion of these solids is at once precipitated. At this point other particles attract and absorb any emulsified grease there may be in the water, as well as organic matter in suspension. These, being lighter than the water, rise to the surface as a thick, soapy scum, overflow the conical sill, and are discharged at the automatic grease-scum outlet.

The water, with the finer particles of solid matter in suspension, flows on to the clarifying tank, through which it slowly rises to the outlet.

The clarifying tank is, in main principle, the subsidence filter first devised by Prof. Wanklyn, but in addition it provides, by the inclination given to the shelves and the provision of discharge passages, for self-clearing and continuous working.

The plant as already described, is complete for the soda treatment of hard water, but in the majority of cases, treatment by lime also is necessary, and the gear by which the lime is fed in exact and correct proportion, is one of the most important features of the "Wollaston" softener.

This dividing gear consists of a special form of three-way valve, fixed on the delivery side of the hard-water pump, and operated by levers attached to the pump piston rod. Assuming that the proportion of lime water required is 25 per cent. of the amount of hard water fed into the plant, the valve will be open to the hard water inlet to the heater during 75 strokes out of every 100 strokes the pump makes, and to the lime-water tank during the remaining 25 strokes. By the slackening of one screw only the cams can be adjusted whilst the gear is running, so as to vary the proportion of water delivered to the lime-water tank from 0 to 50 per cent. of the total delivery of the pump. The pump displacement is positive, so the delivery can be definitely divided into positive proportions, and the force of the pump delivery keeps the pipes free from deposits, or delivers accurately in spite of them, and provides for the agitation of the lime at every stroke. The dividing gear deals with the water before it comes into contact with the lime, and so cannot possibly become clogged, or be put out of action by reason of lime deposit.

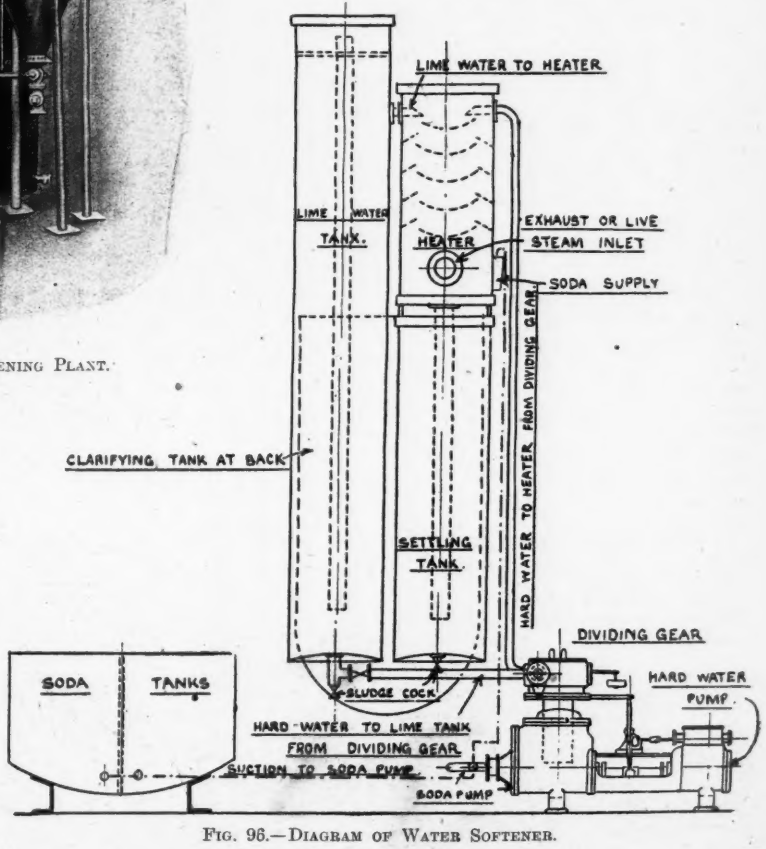

Fig. 96.—Diagram of Water Softener.

Automatic regulation of the "Wollaston" softener is provided

for by a float-operated starting valve or starting switch for the pump. As the supply of reagents is directly due to the operation of the pumps, at whatever rate the pump works, the proportion of the hard water and reagents will remain constant.

The "Wollaston" type of water softener using chemical treatment can be effectively applied to the softening of feed water under pressure. A special design of this plant is successfully at work, treating the water in its course from the feed pump to the boiler.

Rotary Electric Drilling Machine.

This machine which we show in two positions, one (fig. 97) for drilling top and the other (fig. 98) for bottom holes was specially designed and is being manufactured by the Corlett Electrical Engineering Co., Ltd., of Wigan and Newcastle-on-Tyne, for drilling in rock, stone and other strata usually found in the coal measures. These machines have been in use for the past three years in a number of our collieries in different parts of the country. The equipment consists of (*a*) the drilling machine; (*b*) the column, &c., and (*c*) the motor and telescopic shaft. The drill is of the rotary type. Steel and a specially strong bronze are almost exclusively

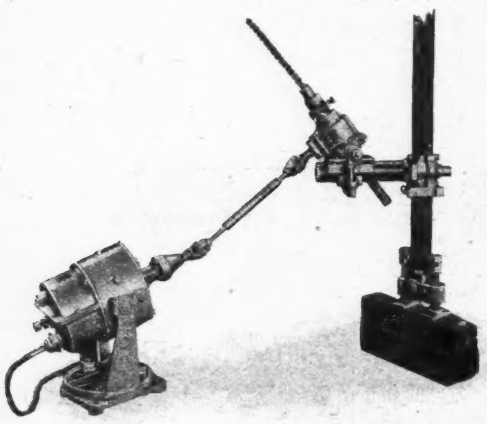

Fig. 97.

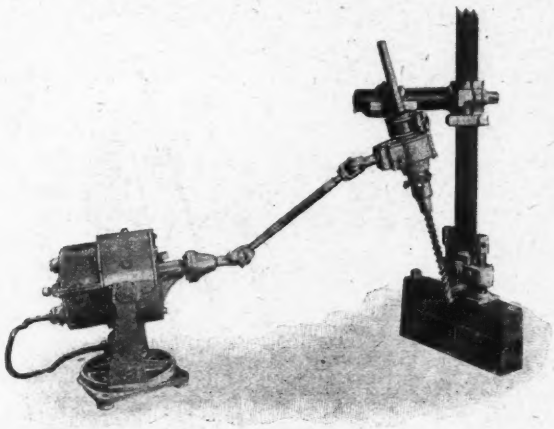

Fig. 98.

used in its construction. The moving parts are few, and there is only one pair of gears—machine cut bevel wheels.

The drill spindle of special steel is threaded its entire length, the chuck being detachable. The thrust bearing is of the conical roller type, of great strength, and built for a working pressure of 6 tons. The feed gear is extremely simple, controlled by a brake, and is adjustable from 1-10th in. per revolution to zero. There are two feed adjusting screws, one on each side of the machine, for convenience in handling in cramped situations. The standard length of travel, without changing a drill, is 22 in. The feed jaws are released and held back by throwing out a link at the drill end of the machine, and the spindle is then free to slide up or down. All parts are enclosed and work in oil. Drills of special steel of twist pattern are used. The finished size of hole is $1\frac{3}{4}$ in.

The column consists of a weldless steel tube, fitted with Jack screws of the usual type, the nuts being of special bronze to avoid rust. It carries a short horizontal arm, free to move round or to slide up and down, and also a safety clamp. The machine slide is fastened to the horizontal arm, to which in turn the drilling machine is secured. To change a drill or fit an extension piece, it is only necessary to slack one nut, slide back the machine, insert the longer drill in the hole or extension piece and slide forward, when the drill spindle and drill must necessarily be properly aligned.

The telescopic shaft consists of a weldless steel tube, with two solid shafts sliding in it, each shaft being fitted with a special universal joint and automatic coupling for attaching to the motor and machine respectively. In the improved joint there are no projections, consequently the risk of danger of accident to attendants is at a minimum.

A 4-B.H.P. motor—either continuous or polyphase type—is employed, fitted with trunnions for fixing to a revolving turn-table, with a flat base for fixing to an ordinary flat-topped colliery tram. The motor can also be tilted at any angle, and a friction clutch is fitted on the spindle, which can be set to slip at any desired overload. It runs at a slow speed, allowing the telescopic shaft to be attached direct to the spindle. The standard continuous current motors are series wound, suitable for 110, 230, or 500 volts, and are gas and water proof. The controlling switch is fitted in a gastight case, and provided with magnetic "blow-outs." The supply cables are connected by means of a detachable plug of a specially strong design.

The standard polyphase motors are of the short-circuited rotor type, wound for 500 volts at 40 periods.

It is claimed for the Corlett drill that it contains few moving parts, all easily accessible; the wearing parts are few, and all are made absolutely to gauge and numbered, so that they can be easily replaced. The best quality of material is used, a very large margin of safety being provided for throughout; for example, the thrust block is made for a working pressure of 6 tons. The machine is worked by two men only, all the parts being light; the weight of the several parts are as follows:—Drilling machine 120 lb.; clip gear 75 lb.; column and arm 280 lb.; motor 600 lb.; telescopic shaft 20 lb.

We understand that holes can be drilled in any position or angle up to 8 or 10 ft. deep without moving the column. All gears are totally enclosed, and the feed screws are quite clear of the telescopic shaft. The machine is primarily intended for driving tunnels in mines, and it will drill into any substance usually met with in the coal measures, but being of the rotary type, the makers do not claim that it can successfully deal with all classes of rock, although it can successfully drill whinstone and other hard rock.

The speed of drilling naturally varies with the nature of the ground, but from figures obtained of a plant worked by the ordinary staff at a colliery, on day wage, driving a tunnel 12 ft. by 6 ft., a round of holes, each 6 ft. 6 in. to 6 ft. deep, finished diameter $1\frac{3}{4}$ in. can be drilled, and all the tackle cleared away ready for shot-firing in three hours; and in another drift, 15 ft. by 8 ft., 13 yds. have been driven in one week.

As a result, it is claimed that the cost of a tunnel is largely reduced, and the rate of progress enormously increased.

(*To be continued.*)

NEW PATENTS APPLIED FOR.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

20,893. "Improvements in holders for incandescent electric lamps and other electric fittings." J. J. Brooke. October 16th.

20,898. "Improvements relating to electrolytic apparatus." C. N. Ruber. (Date applied for under Patents Act, 1901, October 15th, 1904, being date of application in Norway.) October 16th. (Complete.)

20,933. "Improvements in microphones." G. A. Nussbaum. October 16th.

20,950. "Improvements in controlling devices for electric motors applicable to the motors of elevators and the like." Otis Elevator Co., Ltd. (Otis Elevator Co., U.S.). October 16th. (Complete.)

20,960. "Improved non-reversing two-way running trolley pole for electrical traction." H. Quertier. October 16th. (Complete.)

20,990. "Improvements in and relating to dynamo-electric machines." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) October 16th.

20,995. "Improvements in vessels for containing fused salts during electrolysis." S. Cowper-Coles. October 17th.

21,034. "Single-phase alternating current motor with commutating poles." E. Arnold and J. L. La Cour. (Date applied for under Patents Act, 1901, October 17th, 1904, being date of application in Germany.) October 17th. (Complete.)

21,038. "Improvements in or relating to the electrical transmission of power on motor vehicles and boats." H. McNulta. (Date applied for under Patents Act, 1901, December 10th, 1904, being date of application in United States.) October 17th. (Complete.)

21,064. "Improvements in and relating to alternating current electric motors." The British Thomson-Houston Co., Ltd., H. S. Meyer and P. A. Mossay. October 17th.

21,068. "Improvements in apparatus for controlling electrically-propelled trains." Siemens Bros. & Co., Ltd., and F. Lydall. October 17th. (Complete.)

21,070. "Improvements in connection with polyphase alternate current electric commutator machines." Elektricitats-Aktien-Gesellschaft vorm. W. Lahmeyer & Co. (Date applied for under Patents Act, 1901, October 17th, 1904, being date of application in Germany.) October 17th. (Complete.)

21,071. "Improvements in and relating to conduits or casings for electric conductors." R. H. W. Knight and L. Nagel. October 17th.

21,095. "Method for the production of hollow poles of concrete with a metal insertion forming an inter-connected framework for electric conductors and the like." H. Aebi. (Date applied for under Patents Act, 1901, November 21st, 1904, being date of application in Germany.) October 17th. (Complete.)

21,108. "Improved non-slipping device for locomotive, steam, and electric traction engines." A. Marr and T. Chalmers. October 18th.

21,145. "Improvements in and relating to methods of collecting and conveying electric currents." S. von Ammon. October 18th.

21,162. "Telephone receivers and the like." R. B. Bumiller. October 8th. (Complete.)

21,173. "Improvements in installations for electrically igniting the charges of internal combustion engines." A. H. Nicholson. October 18th. (Complete.)

21,181. "Improvements relating to electrical measuring instruments." T. W. Varley. October 18th. (Complete.)

21,198. "Improvements in or connected with the pole-pieces of dynamo-electric machines." J. H. St. H. Mawdsley and J. W. Burleigh. October 18th.

21,202. "Improvements in electric light fittings." Veritys, Ltd., and F. W. Thorpe. October 19th. (Complete.)